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Joint High Speed Sealift (JHSS) Baseline Shaft & Strut (BSS) Model 5653-3: Series 2, Propeller Disk LDV Wake Survey; and Series 3, Stock Propeller Powering and Stern Flap Evaluation Experiments

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14. ABSTRACT

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In order to assist in the design a propeller for the BSS hull, the nominal wakes in the inboard and outboard starboard propeller planes were measured using LDV. The velocity fields were used to determine the average flow near the propeller tip in the event that ducted propellers or podded propulsors were to be designed for this hull. Harmonic content of nominal wake was calculated up to the 16^{th} harmonic for both inner and outer shafts.

The stock propeller powering prediction for the JHSS BSS GB configuration with stern flap installed, with SAD included, no power margin, non-cavitating propellers, at design (DES) displacement, indicates that at the 36 knot speed of interest the

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The selected stern flap design for the JHSS BSS has full-scale dimensions of chord length 12.8ft (3.9m) equivalent to 1.35% LWL, span 52.9ft (16m) representing 80% of the maximum span, and an angle of 10° trailing edge down relative to the local buttock slope at the centerline of the transom. At DES displacement, the stern flap exhibited a reduction in required delivered power of 7.6% at the 36 knot optimization speed, and a reduction in propeller speed of 2.9 RPM.

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ADMINISTRATIVE INFORMATION

Primarily, funding for the various studies and tests that will be performed under this project comes from the JHSS Project Office, NAVSEA 05D1, Project Manager Steven Wynn. The JHSS Hydro Working Group (HWG), which includes representatives from NAVSEA, NSWCCD, ONR and CSC, coordinates all hydrodynamic, propulsion, hull form and structural loads R&D for the JHSS program. Tests were conducted at the David Taylor Model Basin, Naval Surface Warfare Center, Carderock Division Headquarters, (NSWCCD), by the Propulsion and Fluid Systems Division (Code 5400) and the Resistance & Powering Division (Code 5200), under work unit numbers 06-1-2123-405 and 07-1-2125-145.

INTRODUCTION

The Joint High Speed Sealift (JHSS) is a potential FY12 ship acquisition sponsored by OPNAV N42. The program was originally designated the Rapid Strategic Lift Ship (RSLS) as outlined in "Rapid Strategic Lift Ship Feasibility Study Report" [Ref. 1]. In the "Joint High Speed Sealift (JHSS)" presentation [Ref. 2], the ship's capability was broadly described as being able to "Embark design payload, transport it 8,000 nm at 36 knots or more, and disembark it to a seabase or shore facility".

Current tests were conducted on Model 5653-3, scale ratio 34.121, representative of the Joint High Speed Sealift (JHSS) conventional Baseline Shaft & Strut (BSS) hullform with Gooseneck Bulb (GB). The GB was selected for the BSS during the alternate bow evaluations and selection phase of the JHSS BSS Series 1 testing, Cusanelli [Ref. 3]. This report documents two successive series of tests conducted on the JHSS BSS hullform Model 5653-3: (1) Series 2 - Propeller Disk LDV Wake Survey tests, conducted in the fourth quarter FY06, data and analysis presented in Appendix A; and (2) Series 3 - Stock Propeller Powering and Stern Flap Evaluation tests, conducted in the first quarter FY07, data and analysis presented in Appendix B.

The Baseline Shaft & Strut (BSS) hullform is the first tested of three different propulsion systems that are being evaluated for the combined JHSS and Sealift R&D Programs.[1] These three propulsion systems are (1) the conventional shaft and strut configuration, (2) waterjet propulsion (both axial flow and mixed-flow jets), and (3) podded propulsion.

HULL MODEL

Resistance and propulsion Model 5653, representative of the JHSS baseline shaft and struts (BSS) hullform, built of fiberglass to a linear scale ratio l = 34.121, and LBP = 27.86 ft (8.5 m), was manufactured at NSWCCD. This scale ratio was based on the availability of 7.5 inch (19.05 cm) diameter high quality model propellers selected or the JHSS BSS Series 3 stock propeller powering tests. The suffix -3 affixed to the model number denotes the installation of the Gooseneck Bulb, selected as the optimal tested bow design in the Series 1 tests. Table 1 presents a list of JHSS hullform and appendage nomenclature and abbreviations for current tests.

A detailed description of Model 5653, photographs while under construction, and results of the laser inspection, are presented in Ref. 3. Photographs of JHSS Model 5653-3, with stock propeller series 5233-5, in the Carriage 2 dry dock, are presented in Fig. 1 and Appendix B, Fig B1, and installed under Carriage 2 for the Series 3 testing, in Fig. B2.

Table 1. JHSS hullform and appendage nomenclature and abbreviations for current tests

JHSS Baseline Model	Model Number	Abbreviation
Baseline Shaft & Strut Hull, Open Propellers (full model)	5653	BSS
w/ Gooseneck Bulb (insert)	5653-3	GB
JHSS Propulsion Configurations		**Abbreviation**
Stock Open Propulsion, Propeller Series 5233-6, 4 total		SOP
JHSS Appendages / Configurations		**Abbreviation**
Bare Hull (No appendages, hull penetrations sealed)		BH
Fully Appended (all associated appendages installed)		FA
Fully Appended with rings installed on TE of main barrel to enlarge diameter to that of stock propeller hub		FA*
Propulsion Shaftlines (4): Open Shafts, Struts, Barrels		S&S
Rudders (2)		RUD
Stern Flap #1; 1.0%LBP chord, Max span		SF1
Stern Flap #2; 0.75%LBP chord, Max span		SF2
Stern Flap #3; 1.0%LBP chord, 80%Max span		SF3
Stern Flap #4; 1.25%LBP chord, 80%Max span		SF4
JHSS Loading Conditions	**Long Tons**	**Abbreviation**
Design Displacement	36491	DES
Heavy Displacement (Design +10%)	40140	HVY
Light Displacement (Design -10%)	32841	LITE

A modification was made to the original supplied rudder design. The original design and location of the rudder placed it into a position of interference with the propeller hub. The rudder position was moved aft to allow for the minimum clearance required between the rudder leading edge and the shaftline, to accommodate the removal of the propeller hubs. The closer proximity of this aft rudder position to the transom necessitated that the rudder chord length be reduced to 68% that of the original design. The rudder alignment experiment reported herein was conducted with the reduced chord, repositioned rudders.

[1] McCallum, D. et. al., "Joint High Speed Sealift (JHSS) Progress Report - Summary of Hullform Development" (Report in preparation).

To produce turbulent flow along the model, turbulence stimulator studs of 1/8 inch diameter by 1/10 inch height, spaced 1 inch apart, were affixed to the model approximately 2 inches aft of the stem, and continuing down to and around the bulbs approximately 2 inches aft of the FP.

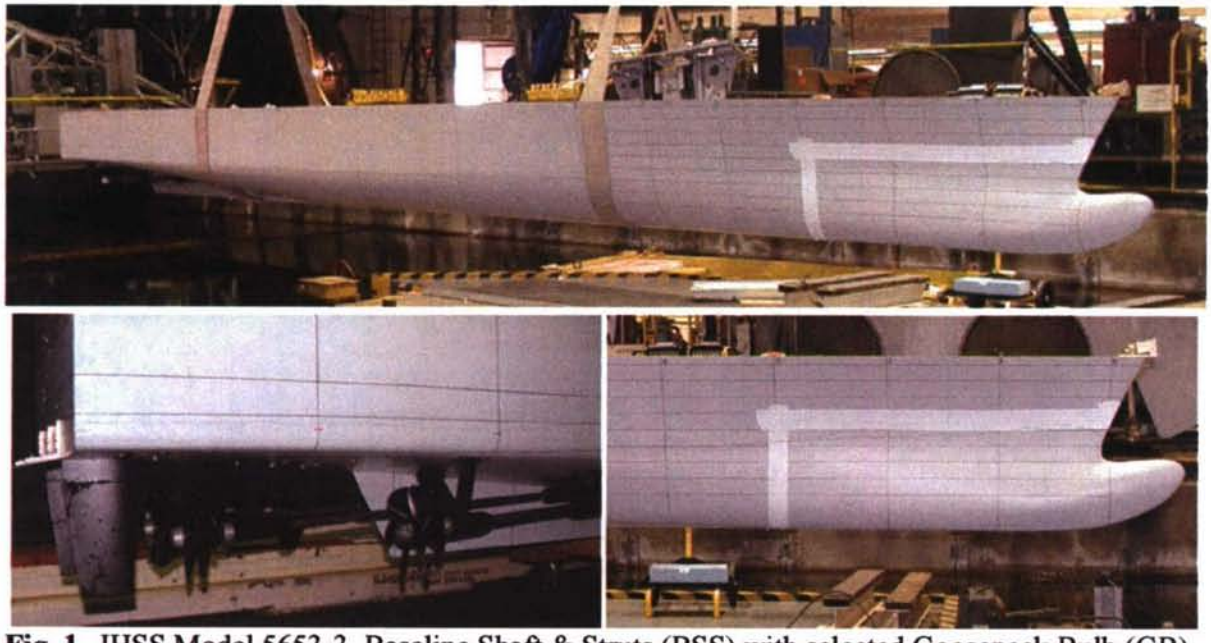

Fig. 1. JHSS Model 5653-3, Baseline Shaft & Struts (BSS) with selected Gooseneck Bulb (GB) and model stock propeller series 5233-5

Stock Propeller Series

This scale ratio was based on the availability of 7.5 inch (19.05 cm) diameter high quality model propellers designed and manufactured for the PC 1 program. The PC propellers were designed for high-speed open flow. These were the selected model stock propellers for the JHSS BSS Series 3 stock propeller powering tests.

The PC 1 model-scale propeller series is 5233A, 5234, 5234A, and 5235, a matching set of (2 each) left-handed (LH) and right-handed (RH) propellers. These stock propellers are representative of full-scale 6-bladed propellers with a diameter of 21.33ft (6.5m) and a pitch-to-diameter ratio (P/D) of 1.449 at the 0.7 radius. Photographs of the model stock propeller series, installed on Model 5653-3 are included in Fig. 1 and in Appendix B, Fig. B1. The existing open water performance characteristics for stock propeller series 5233-5, as presented Table B3, were used during the powering data reduction.

Stern Flap Candidate Designs

A judgment was made by the Code 5200 Test Engineer as to the stern flap maximum span, to both to avoid the radius at turn of bilge and the high-speed race off the corners of the transom when underway. For the JHSS BSS, the flap max span was judged to be 86.4% Bx, equivalent to a full-scale span of 68.2ft. Listed in Table 2 are the principal dimensions for the four stern flaps tested on Model 5653-3.

The initial flap, Flap#1, was designed to the max span with a 1% LBP chord length. For Flap#2, the max span was held constant, and chord was reduced to 0.75%LBP. For Flap#3, the 1%LBP chord was again used, with the span reduced until the total flap area was equivalent to that of Flap#2. For Flap#4, the reduced span was retained, and chord was increased until the area was equivalent to Flap#1.

Table 2. JHSS BSS stern flap candidate design principal dimensions

	Flap#1	Flap#2	Flap#3	Flap#4
Flap Chord, ft (%LWL)	9.5 (1.0%)	7.1 (0.75%)	9.5 (1.0%)	12.8 (1.35%)
Flap Span, ft (%Max)	68.2 (Max)	68.2 (Max)	52.9 (80%)	52.9 (80%)
Flap Area, ft^2	610	465	465	610

The stern flaps were manufactured out of $1/16^{th}$ inch thick aluminum plate, cut and shaped to the stated dimensions at model scale, and then bent and fitted to the transom knuckle. The flaps were fastened to the transom with aluminum angle brackets manufactured at specified angles of 0 degrees (parallel to the local slope at the centerline of the transom) through 15 degrees trailing edge down (TED). Any small gap between the leading edge of the flap and the transom knuckle, as a result of the variation in angles, was bridged by a fairing strip made of modelers tape.

Instrumentation – Series 2: LDV Wake Survey

Complete descriptions of the Laser Doppler Velocimetry (LDV) apparatus, test procedures, data reduction, and coordinate transformations are presented within Appendix A, and briefly summarized herein. The LDV system consisted of two TSI Model 9832 fiber-optic probes, mounted rigidly together on a streamlined strut in order to keep the measurement volumes aligned. In order to measure at different points in the flow, the probes could be translated in a plane perpendicular to the model axis as a unit through a two-component, computer controlled traverse. Illustrations and photographs of the LDV test system apparatus are presented in Appendix A, Fig. A1-A3, and Fig. 2.

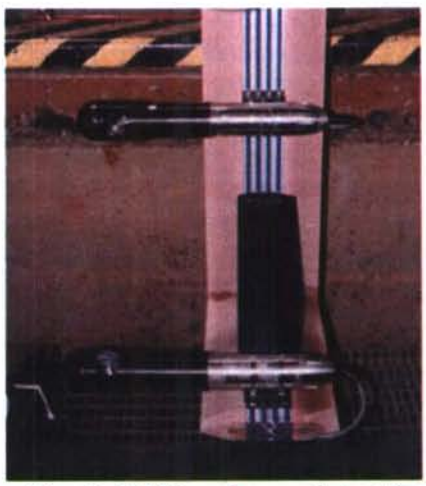

Fig. 2. LDV probes and strut in dry dock

Nominal wake measurements were made in way of the inboard and outboard starboard propeller planes, at a model speed of 6.16 knots, which corresponded to a full-scale speed of 36 knots. Measurements were taken with the BSS Gooseneck bulb, with the model fully appended and at the design draft. The model was fixed at the correct dynamic sinkage and trim for this condition. The model was unpropelled, with 1.5 inch long dummy hubs in place of the propellers. These hubs were shorter than the standard propeller hubs so that unobstructed measurements could be made just aft of the truncated dummy hubs, at the nominal propeller plane. At each point in the flow, measurements were obtained for 4 seconds. In this time between 1000 and 8000 velocity realizations were recorded for each velocity component. Measurements were made in a plane perpendicular to the direction of model travel. The measurement plane was therefore not perpendicular to the shaft, and the measurements were then projected onto a plane perpendicular to the shaft.

The primary source of measurement uncertainty is flow fluctuations, which occur on time scales which are significant in comparison to the necessarily finite measurement time. These long-scale fluctuations result in an uncertainty in the measured velocity of approximately $0.007U_\infty$ in the shaft wake region, and approximately $0.005U_\infty$ in the rest of the flow field. Angular uncertainty is approximately 0.5°.

Instrumentation – Series 3: Resistance and Powering

The linear bearing, floating platform "Cusanelli" tow post [Ref. 4], was utilized for the forward attachment point of the model to the towing carriage. Mechanical connection between the tow post and model was made through a double-axis gimbal assembly. When attached

through the floating platform tow post system, the model is restrained in surge, sway, and yaw, but is free to pitch, heave, and roll. The location of the model tow point was at ship Station 5, parallel to, and at the same level as, the original 8.6m (28.22ft) DWL. For the aft attachment point, the standard 'grasshopper' bracket was utilized, attached at ship Station 15. The counter weights and vertical arm were balanced, in place, so that the arm would not impart any vertical force on the model.

Model resistance (drag) measurements were collected using a DTMB 4-inch block gauge, of 200 lbf. capacity. Model side force measurements were collected with a DTMB 4-inch block gauge, of 50 lbf. capacity. Side force is monitored at the tow post attachment point during calm water experiments in order to maintain an essentially zero side force to insure zero yaw angle. Dynamic sinkage (defined as positive downward) was measured by wire potentiometers, which were located at the intersection of the deck line at Station 1 forward and Station 15 aft.

The thrust and torque on all four propeller shafts were measured with Kempf and Remmer's (K&R) model R31 dynamometers, of 22lbf. thrust (T) / 35in-lbf. torque (Q) capacity. To insure equivalent shaft rotational speed (RPM), the inboard and outboard propeller shaft pairs, port and starboard, were driven through 1:1 drive ratio "T" gearboxes and coupled so that both shaft pairs were each powered by a single constant-torque electric drive motor. The two drive motors were electronically synchronized to maintain equivalent RPM. Shaft rotation for all four propellers was outboard-over-the-top. A 60 tooth wheel and magnetic pickup / pulse counter system was used to determine shaft RPM, inboard and outboard pairs.

Calibration of all aforementioned instrumentation was performed prior to the tests in the NSWCCD Code 5200 calibration lab.

Vessel Displacement and Trim

Series 2 LDV wake survey experiments were conducted at the dynamic sinkage and trim conditions equivalent to values measured during the Series 1 experiments with the model ballasted to Design displacement (DES) of 36,490 tons. DES was determined to be representative of a likely loading scenario for the JHSS BSS.

The Series 3 model tests were conducted at two displacement conditions, the design displacement (DES) of 36,490 tons, and a heavy displacement (HVY) of 40,140 tons representing a 10 percent increase in displacement from design. Both conditions were tested for resistance and stock propeller powering at even keel (zero static trim). In addition, resistance tests only were conducted at DES for trimmed conditions of $\pm$ 5 ft. The Test Agenda for the JHSS BSS GB Series 3 testing is presented in Appendix B, Table B1. Ship/model test parameters for JHSS BSS GB, as tested, are presented in Appendix B, Table B2. Model ballasting was adjusted so as to represent the specified ship displacement.

SERIES 2: LDV PROPELLER DISK WAKE SURVEYS

LDV Propeller disk nominal wake data and results, including harmonic analysis, are presented in their entirety in Appendix A, Tables A1-A12 and Figures A4-A26.

Nominal Wake

Nominal wake measurements were made in way of the outboard and inboard starboard propeller planes, and coordinate transformations were performed on the nominal wake data in order to place it in a shaftline coordinate system as presented in Fig. 3 (reproduced from Appendix A, Figures A4 and A7, respectively), where:

- U_∞ = Free stream velocity (Model speed)
- U_s = Velocity in direction of shaft, normalized by U_∞ (+ downstream along shaftline)
- z_o = Coordinate in the vertical plane, perpendicular to the shaft, normalized by L (+ up)
- y_p = Coordinate in the horizontal plane, perpendicular to the shaft, normalized by L (+ starboard)

Represented by the vectors are:

- U_p = Velocity in horizontal plane, perpendicular to the shaft, normalized by U_∞ (+ starboard)
- U_o = Velocity in vertical plane, perpendicular to the shaft, normalized by U_∞ (+ up)

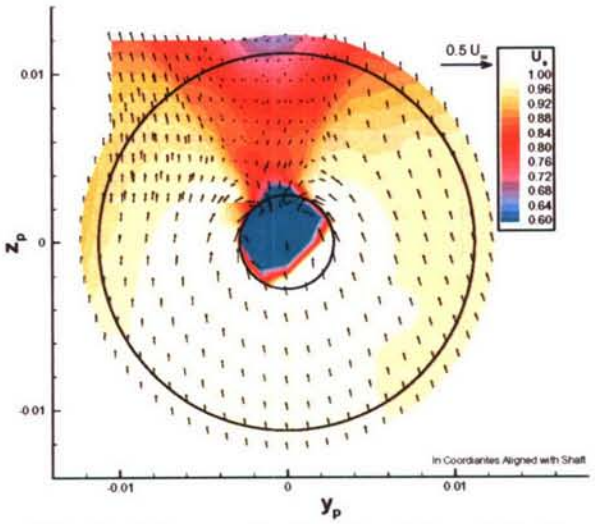

Fig. 3a. Measured velocities, inboard shaft

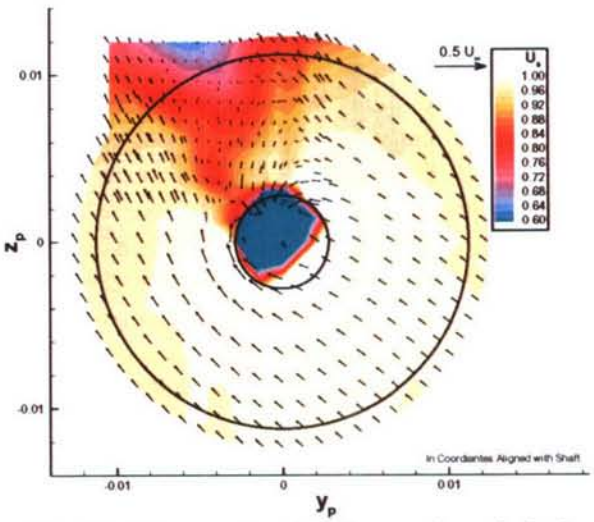

Fig. 3b. Measured velocities, outboard shaft

The outboard shaft nominal wake is relatively uniform over most of the disk, with U_s equal to approximately 0.98 U_∞, U_p equal to approximately 0.08 U_∞, and U_o equal to approximately -0.07 U_∞. The regions where this does not hold are in the hub wake, where the streamwise velocity is very much lower, and to the upper inboard side of the hub, where the shaft and strut wakes affect the flow. The strut wakes are thin and not very strong. The inboard strut wake is difficult to distinguish from the shaft wake.

The inboard wake is also relatively uniform over most of the disk, with U_s equal to approximately 0.98 U_∞, U_p equal to approximately 0.08 U_∞, and U_o equal to approximately -0.01 U_∞ in the free stream. Since the inboard shaft is not toed out, the shaft wake is nearly vertical. The strut wakes cannot be easily distinguished from the shaft wake.

Propeller Plane Average Flow Alignment

The velocity fields were used to determine the average flow near the propeller tip in the event that ducted propellers or a podded propulsor were to be designed for this hullform. The average flow velocities and angles were calculated for the region from $0.80 \leq r/R \leq 1.05$. The results of these calculations show that the flow, in the vertical direction, is moving upward an average of 1.8 degrees through the inboard propeller plane and 1.6 degrees through the outboard propeller plane, and likewise in the horizontal direction, is moving inward (towards centerline) an average of 0.8 degrees and 1.0 degrees for the inboard and outboard planes, respectively.

Harmonic Content

In order to perform a harmonic analysis on the nominal wake, the measured data was interpolated onto a densely populated circular grid. The interpolated circular grid allows the velocity profiles to be extracted along any give circumference. Harmonic content of nominal wake was calculated at values of r/R = 0.5, 0.7, 0.9, and 1.0, for both inner and outer shafts. Computations were made up to the 16^{th} harmonic.

SERIES 3: STOCK PROPELLER POWERING

The BSS Series 3 Test Agenda is presented as Appendix B, Table B1. Tests were conducted on Model 5653-3 in the NSWCCD Deepwater Towing Basin #2 using Carriage 2. Dimensions of the towing basin are 1886 ft length, 50.96 ft width, by 22 ft depth. The cross-sectional area of the tank will provide sufficient area to eliminate the need for blockage correction. Resistance and stock propeller powering experiments were conducted on Model 5653-3 and analyzed according to standard NSWCCD practice for this type of vessel as set fourth by Grant and Wilson [Ref. 5].

The ship-model correlation allowance of $C_A = 0.0$ was recommended by NSWCCD Code 5200 based on the NAVSEA guidance as modified by more recent correlation allowance experience. The value of $C_A = 0.0$ was agreed upon by the JHSS HWG. Predictions are made for the full-scale JHSS operating in smooth, deep, salt water, with a uniform standard temperature of 59°F.

Rudder Angle Optimization

Rudder angle optimization experiments were conducted on Model 5653-3, under power, with the stock propellers. Rudder angles of zero degrees (parallel to ship centerline) through 6 degrees trailing edge inward (TEI) were tested, at ship speeds of 24 and 36 knots. Both port and starboard rudders were turned simultaneously. Results of the rudder optimization experiment are presented in Appendix B, Fig. B4 and Table B5. Optimum rudder angle was determined as that angle which exhibited the lowest total delivered power. Optimum rudder angle for the JHSS BSS was determined to be 3 degrees TEI. This angle exhibited a minimum delivered power at both tested ship speeds. All resistance and powering tests reported herein were conducted with the model rudders set to this optimum rudder angle.

Stern Flap Evaluation and Selection

For the stern flap evaluation, comparative resistance experiments were conducted on Model 5653-3, with each of the aforementioned four stern flap designs. Resistance was measured at ship speeds of 18, 24, 30, and 36 knots, for flap angles of 0, 5, 10, and 15 degrees TED. Resultant effective power was compared to that of the JHSS Model 5653-3 without a stern flap installed, presented in Appendix B, Fig. B5 and Table B6. Since a speed-time profile did not exist for the JHSS, it was decided by the HWG that the stern flap selection criteria should be primarily based on maximizing high speed resistance reduction, as measured at 36 knots, without incurring a greater than 20 percent resistance penalty at low speed, as indicated at 24 knots. Of the stern flaps tested on Model 5653-3, Flap#4 at 10 degrees TED, Fig. 4, exhibited the optimal performance at these dual criteria.

Fig. 4. Selected Stern Flap#4 at 10° trailing edge down

The selected stern flap has full-scale dimensions of chord length 12.8ft (3.9m) equivalent to 1.35% LWL, span 52.9ft (16m) representing 80% of the maximum span, and an angle of 10° trailing edge down relative to the local buttock slope at the centerline of the transom. This

selected flap design effected the maximum resistance reduction at 36 knots of 4.7% relative to the hull without stern flap, and yet still maintained approximately a 1% resistance reduction at 24 knots. Results of the stern flap evaluation are presented in Appendix B, Fig. B6 and Table B7.

Resistance and Stock Propeller Powering

All JHSS BSS Series 3 resistance tests were conducted through the entire speed range of 15 knots through 45 knots, as requested by the JHSS Hydro Working Group (HWG). The powering experiments were conducted from 15 knots up to and through speeds requiring greater than the foreseeable available full installed power for the hullform, and continued until the maximum safe operational limits due to the dynamometer capacities were approached. The resistance and powering tests were conducted at two displacement conditions, the design displacement (DES) of 36,490 tons, and a heavy displacement (HVY) of 40,140 tons representing a 10 percent increase in displacement from design. DES tests were conducted both with and without the selected stern flap, while HVY tests were conducted only with the flap. In addition, resistance tests only, without flap installed, were conducted at DES for trimmed conditions of $\pm$ 5 ft. All resistance and powering experiments were conducted with the rudders set to 3 degrees trailing edge inward, as determined during the rudder angle optimization.

Results of the Series 3 tests, in their entirety, are presented in Appendix B, Figures B5-B9 and Tables B6-B12 for the resistance tests, and are presented in Figures B10-B12 and Tables B13-B16 for the stock propeller powering tests. The powering predictions contained within Appendix B are presented both with and without still air drag (SAD) included, but do not include any power margin. All powering predictions are for a non-cavitating stock propeller design. SAD was calculated using a frontal reference area of 8269 ft^2 (estimated by $0.75Bx^2$) and a still air drag coefficient $C_{AA} = 0.75$.

As directed by the JHSS HWG, the stock propeller powering is presented with SAD included, but without a power margin, and with non-cavitating propellers. A brief summary of the resistance and stock propeller powering for the JHSS BSS GB, with SAD included, is presented in Table 3. Stock propeller powering results, at DES and HVY displacements, with the selected stern flap installed, are presented in Fig. 5.

Table 3. Summary of JHSS BSS GB resistance and stock propeller powering (with SAD)

	BSS GB DES w/SAD			BSS GB DES Flap#4 w/SAD			BSS GB HVY Flap#4 w/SAD		
VS (kts)	PE (hP)	PD (hP)	RPM	PE (hP)	PD (hP)	RPM	PE (hP)	PD (hP)	RPM
18	13425	19743	65.2	13134	19427	64.8	14027	20965	65.4
24	30035	45551	86.7	29275	44175	85.7	30870	46473	86.2
30	57239	88914	107.6	54891	83327	106	58046	87922	106.7
36	103719	161728	129.6	99347	149443	126.7	105037	156980	128.1
39	151858	235042	142.8	145472	218175	140.1	157146	232666	141.8
42	222052	339657	158.5	214389	318908	156.1	234284	343760	157.6
	VS Max (kts)	PD (hP)	RPM	VS Max (kts)	PD (hP)	RPM	VS Max (kts)	PD (hP)	RPM
	39.2	240000	143.6	39.7	240000	143.8	39.2	240000	142.9

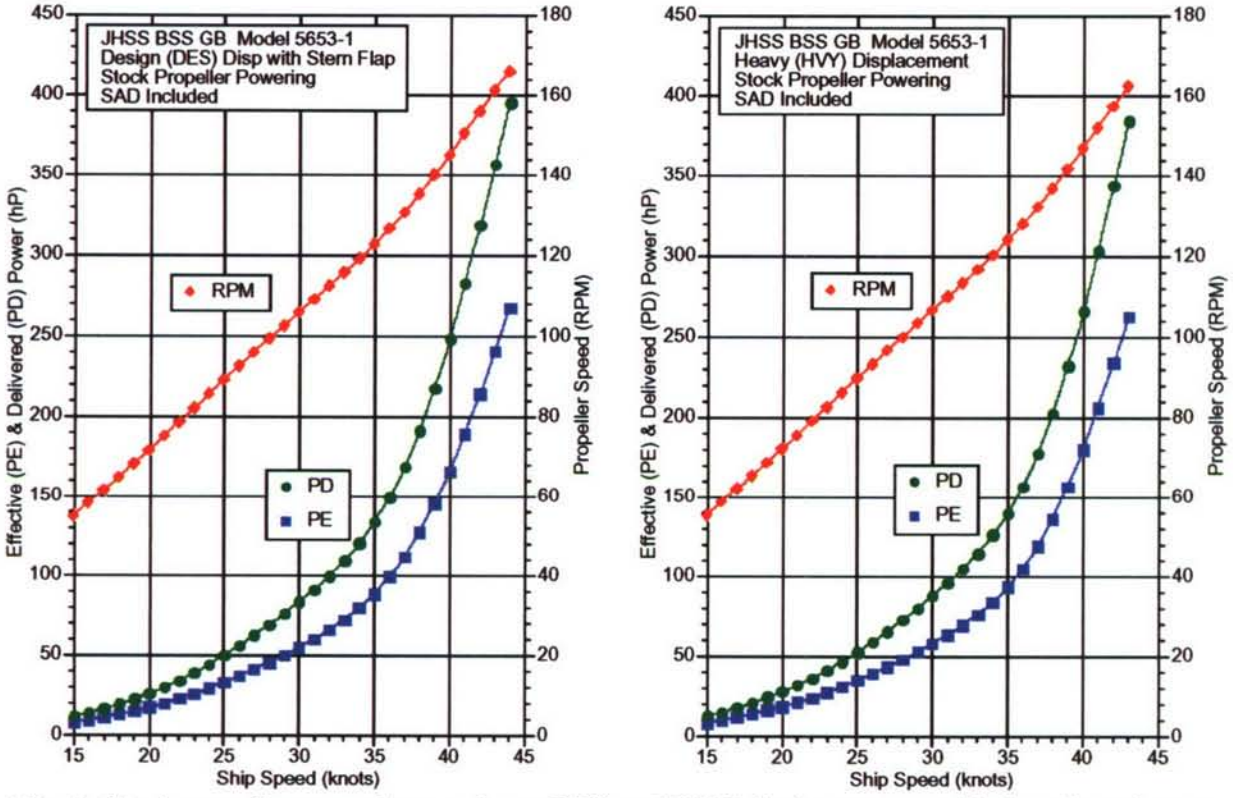

Fig. 5. Stock propeller powering results, at DES and HVY displacements, with the selected stern flap installed

The stock propeller powering prediction for the JHSS BSS GB, with SAD included, no power margin, non-cavitating propellers, at design (DES) displacement, indicates that at the 36 knot speed of interest the total delivered power required will be 161,730 hP (120,600 kW), and to attain the desired speed of 39 knots will require 235,040 hP (175,270 kW). The installation of the selected stern flap design reduces both the 36 and 39 knot delivered power requirements to 149440 hP (111,440 kW) and 218,180 hP (162,690 kW), respectively. For the heavy (HVY) displacement, with flap, the 36 and 39 knot delivered power requirements are 156,980 hP (117,060 kW) and 232,670 hP (173,500 kW), respectively.

Attainable Speed Estimate

An attainable speed estimate for the JHSS BSS GB is presented in Table 2, based on the Model 5653-3 stock propeller powering test results, with SAD included, no power margin, non-cavitating propellers (i.e. assuming no propeller efficiency losses due to cavitation). For the JHSS BSS, the total delivered power available per shaft is expected to be 60,000 hP (44740 kW), indicating a total delivered power available to the four propellers of 240,000 hp (178,970 kW). The attainable speeds presented were estimated using total expected engine delivered power as the only limiting criteria (i.e. excluding engine speed, torque, inboard-to-outboard shaft powering inequalities, etc.). The estimated attainable speed at 240,000 hP (178,970 kW) is 39.2 knots at DES, 39.7 knots at DES with selected stern flap installed, and 39.2 knots at HVY with stern flap. Therefore, the 39 knot desired speed appears to be achievable within the expected total installed power for the JHSS BSS.

Comparison to Pre-Test Estimate

A pre-test estimate of JHSS BSS powering was prepared for the JHSS HWG. Methodology for the pre-test powering estimate, in brief, is as follows:

- Bare hull PE estimate from regression analysis
- Appended PE estimate included the following added to the bare hull PE estimate
  1. Shaft and Strut (4 shaftlines) resistance calculated using a per shaft drag coefficient Cssl = 0.0045, defined as: Cssl = $0.5*\rho*V^2$*exposed shaft length*propeller diameter
  2. Bilge Keel (2) resistance determined from Peck's formula [6] using estimated bilge keel dimensions and a C_f multiplier of 1.516.
  3. Rudder (2) resistance determined from Peck's Formula using estimated rudder dimensions.
- Powering was estimated using
  1. Appended PE estimate
  2. Estimated interaction coefficients 1-t = 0.85; 1-wt (inbd, otbd) = 1-wq (inbd, otbd) = 0.93
  3. Open water propeller coefficients from stock propeller series 5233-5

Results of the JHSS BSS GB Model 5653-3 stock propeller powering at DES displacement were compared to pre-test estimates prepared for the JHSS HWG, and are presented, in brief, in Table 4. JHSS BSS GB Model 5653-3 test, at DES displacement, without stern flap, exhibited a resistance (averaged across the entire speed range) approximately 11.5% lower than that of the pre-test estimate. Stock propeller powering indicated an average required delivered power approximately 11.0% lower, with an average required propeller speed of 1.5 RPM higher, than that of the pre-test estimate.

Table 4. JHSS BSS GB stock propeller powering comparison to pre-test estimate

	Pre-Test Estimate w/SAD			BSS GB DES w/SAD			Test Results vs Pre-Test Est		
VS (kts)	PE (hP)	PD (hP)	RPM	PE (hP)	PD (hP)	RPM	PE Ratio	PD Ratio	RPM delta
18	15016	22714	64.2	13425	19743	65.2	0.894	0.869	+1.0
24	35438	53614	85.6	30035	45551	86.7	0.848	0.850	+1.1
30	67124	101680	106.4	57239	88914	107.6	0.853	0.874	+1.2
36	113510	172121	127.2	103719	161728	129.6	0.914	0.940	+2.4
39	163083	246233	140.7	151858	235042	142.8	0.931	0.955	+2.1
42	238089	359326	156	222052	339657	158.5	0.933	0.945	+2.5

Stern Flap Power Reduction

The selected stern flap has full-scale dimensions of chord length 12.8ft (3.9m) equivalent to 1.35% LWL, span 52.9ft (16m) representing 80% of the maximum span, and an angle of 10° trailing edge down relative to the local buttock slope at the centerline of the transom. Results of the JHSS BSS GB Model 5653-3 resistance and stock propeller powering at DES displacement, comparative tests with and without the selected stern flap installed, are presented, in brief, in Table 5.

Table 5. JHSS BSS GB stern flap powering reduction

	BSS GB DES w/SAD			BSS GB DES Flap#4 w/SAD			Flap vs No Flap @DES		
VS (kts)	PE (hP)	PD (hP)	RPM	PE (hP)	PD (hP)	RPM	PE Ratio	PD Ratio	RPM delta
18	13425	19743	65.2	13134	19427	64.8	0.978	0.984	-0.4
24	30035	45551	86.7	29275	44175	85.7	0.975	0.970	-1.0
30	57239	88914	107.6	54891	83327	106.0	0.959	0.937	-1.6
36	103719	161728	129.6	99347	149443	126.7	0.958	0.924	-2.9
39	151858	235042	142.8	145472	218175	140.1	0.958	0.928	-2.7
42	222052	339657	158.5	214389	318908	156.1	0.965	0.939	-2.4

During the JHSS BSS GB Model 5653-3 stock propeller powering tests, at DES displacement, the stern flap exhibited a reduction in required delivered power of 7.6% at the 36 knot optimization speed, and a reduction in propeller speed of 2.9 RPM. The flap maintained a reduction in powering as low as 17 knots. Averaged across the entire speed range, the stern flap effected a reduction in delivered power of approximately 4.7%, and a reduction in propeller speed of 1.6 RPM.

Displacement Effects

JHSS BSS GB Model 5653-3 stock propeller powering was conducted at two displacement conditions, design displacement (DES) of 36,490 tons, and a heavy displacement (HVY) of 40,140 tons representing a 10 percent increase in displacement from design. A comparison of the test results from the DES and HVY displacements is presented, in brief, in Table 6. Averaged across the speed range, the 10% increase in displacement effected an increase in resistance and power of 6.4% and 6.2%, respectively, and an increase in propeller speed of 0.9 RPM.

Table 6. JHSS BSS GB stock propeller powering, HVY versus DES

	BSS GB DES Flap#4 w/SAD			JHSS BSS GB HVY Flap#4			HVY vs DES (w/Flap#4)		
VS (kts)	PE (hP)	PD (hP)	RPM	PE (hP)	PD (hP)	RPM	PE Ratio	PD Ratio	RPM delta
18	13134	19427	64.8	14027	20965	65.4	1.068	1.079	+0.6
24	29275	44175	85.7	30870	46473	86.2	1.054	1.052	+0.5
30	54891	83327	106.0	58046	87922	106.7	1.057	1.055	+0.7
36	99347	149443	126.7	105037	156980	128.1	1.057	1.050	+1.4
39	145472	218175	140.1	157146	232666	141.8	1.080	1.066	+1.7
42	214389	318908	156.1	234284	343760	157.6	1.093	1.078	+1.5

Trim Effects

To evaluate the effects of large static trim variations on resistance, tests were conducted on the JHSS BSS GB Model 5653-3 (without stern flap), at DES displacement, for static trim conditions of $\pm$ 5 ft. For clarification, a positive trim of +5 ft indicates that the draft at the forward perpendicular (FP) is 5 ft less than that of the aft perpendicular (i.e. the bow would be up, whereas the stern would be down, relative to a static even keel position). A comparison of the test results from the $\pm$ 5ft trim variations versus even keel is presented, in brief, in Table 7.

Table 7. JHSS BSS GB resistance effects of $\pm$ 5ft static trim variations

VS	BSS GB DES Even Keel	+ 5ft Trim (Bow Up, Stern Down)		- 5ft Trim (Bow Down Stern Up)	
(knots)	PE (hP)	PE (hP)	PE ratio	PE (hP)	PE ratio
18	13050	14814	1.135	12233	0.937
24	29147	32517	1.116	28126	0.965
30	55505	59748	1.076	54785	0.987
36	100723	106133	1.054	100430	0.997
39	148049	153664	1.038	149143	1.007
42	217294	221200	1.018	221265	1.018

On the JHSS BSS, the +5ft static trim condition, which in effect, deeply submerges the transom, results in a substantial 8.4% increase in resistance when averaged across the speed range. The -5ft static trim condition causes the transom to be lifted clear of the water surface, and results in decreased resistance up to a ship speed of 37 knots, thereafter, it effects a slight

increase in resistance. Averaged across the speed range, the -5ft static trim condition results in a resistance reduction of 2.2%.

Model Test Uncertainties (Resistance & Powering)

Model 5653-3 measurement uncertainties were determined for the quantities of model speed, and hull resistance, and for combined inboard and outboard shafts quantities of shaft thrust, torque, and rotational speed (RPM). The values for torque and RPM were then used to determine the uncertainty in the calculation of delivered power. Measurement uncertainties were determined at speeds of 24 and 36 knots full-scale.

Model 5653-3 measurement uncertainties are presented in Appendix B, Table B17. Resistance measurement uncertainties, at 24 and 36 knots, were determined to be $\pm$1.1% and $\pm$0.6% of the measured nominal mean values, respectively. Likewise, the delivered power measurement uncertainties were $\pm$2.2% and $\pm$1.8%. The stated uncertainties for measured model delivered power reflect the combined measurement uncertainties of eight model quantities, shaft torque and RPM, for each of four shafts.

CONCLUSIONS

Model 5653-3, scale ratio 34.121, was constructed to represent the Joint High Speed Sealift (JHSS) conventional Baseline Shaft & Strut (BSS) hullform. The -3 suffix denotes the installation of the Gooseneck Bulb (GB), which was selected for this hullform during a previous series of resistance tests.

In order to assist in the design a propeller for the BSS hull, the nominal wakes in the inboard and outboard starboard propeller planes were measured using LDV. The outboard shaft nominal wake is relatively uniform over most of the disk, with U_s equal to approximately 0.98 U_∞, U_p equal to approximately 0.08 U_∞, and U_o equal to approximately -0.07 U_∞. The regions where this does not hold are in the hub wake, where the streamwise velocity is very much lower, and to the upper inboard side of the hub, where the shaft and strut wakes affect the flow. The strut wakes are thin and not very strong. The inboard strut wake is difficult to distinguish from the shaft wake. The inboard wake is also relatively uniform over most of the disk, with U_s equal to approximately 0.98 U_∞, U_p equal to approximately 0.08 U_∞, and U_o equal to approximately -0.01 U_∞ in the freestream. Since the inboard shaft is not toed out, the shaft wake is nearly vertical. The strut wakes cannot be easily distinguished from the shaft wake.

The velocity fields were used to determine the average flow near the propeller tip in the event that ducted propellers or podded propulsors were to be designed for this hull. Harmonic content of nominal wake was calculated up to the 16th harmonic for both inner and outer shafts.

Optimum rudder angle for the JHSS BSS was determined to be 3 degrees TEI. This angle exhibited a minimum delivered power at both tested ship speeds. All resistance and powering tests reported herein were conducted with the model rudders set to this optimum rudder angle.

A series of tests were performed to evaluate and select a stern flap for the JHSS BSS. The selected stern flap has full-scale dimensions of chord length 12.8ft (3.9m) equivalent to 1.35% LWL, span 52.9ft (16m) representing 80% of the maximum span, and an angle of 10° trailing edge down relative to the local buttock slope at the centerline of the transom. At DES displacement, the stern flap exhibited a reduction in required delivered power of 7.6% at the 36 knot optimization speed, and a reduction in propeller speed of 2.9 RPM. The flap maintained a reduction in powering for ship speeds as low as 17 knots.

The stock propeller powering prediction for the JHSS BSS GB, with SAD included, no power margin, non-cavitating propellers, at design (DES) displacement, indicates that at the 36 knot speed of interest the total delivered power required will be 161,730 hP (120,600 kW), and to attain the desired speed of 39 knots will require 235,040 hP (175,270 kW). The installation of

the selected stern flap design reduces both the 36 and 39 knot delivered power requirements to 149,440 hP (111,440 kW) and 218,180 hP (162,690 kW), respectively. For the heavy (HVY) displacement, with flap, the 36 and 39 knot delivered power requirements are 156,980 hP (117,060 kW) and 232,670 hP (173,500 kW), respectively.

This 39 knot desired speed appears to be achievable within the expected total installed power for the JHSS BSS of 240,000 hP (178,970 kW). The estimated attainable speed is 39.2 knots at DES, 39.7 knots at DES with selected stern flap installed, and 39.2 knots at HVY with stern flap.

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Calibration of test instrumentation was performed by D. Mullinix (CSC).

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APPENDIX A:

PROPELLER NOMINAL WAKES

TABLES OF APPENDIX A

FIGURES OF APPENDIX A

FIGURES OF APPENDIX A (continued) Page

Symbols

L	Length of hull at waterline
i	Shaft incline, degrees (+ shaft down aft)
n	Propeller rotational speed, rev/s
o	Direction in the horizontal plane, perpendicular to the shaft (+ starboard)
p	Di Direction in the vertical plane, perpendicular to the shaft (+ up)
q	Root-mean-square (RMS) fluctuation of velocity, TKE = $q^2/2$, normalized by U_∞
s	Direction along the shaft (+ downstream)
t	Shaft toe (+ out aft)
U	Magnitude of total velocity
U_1	First measured component of velocity, in direction of model axis
U_2	Second measured component of velocity
U_3	Third measured component of velocity
U_o	Velocity in o direction, normalized by U_∞ (+ starboard)
U_p	Velocity in p direction, normalized by U_∞ (+ up)
U_r	Velocity in radial direction from shaft, normalized by U_∞ (+ out)
U_s	Velocity in shaft direction, normalized by U_∞ (+ aft)
U_t	Velocity in tangential direction from shaft, normalized by U_∞ (+ CCW looking upstream)
U_x	Velocity in direction of model travel, normalized by U_∞ (+ downstream)
U_y	Velocity in horizontal direction, perpendicular to model travel, normalized by U_∞ (+ starboard)
U_z	Velocity in vertical direction, normalized by U_∞ (+ up)
U_∞	Model speed
x	Coordinate in horizontal plane, in direction of model travel, from bow waterline, normalized by L
y	Coordinate in horizontal plane, perpendicular to x, from centerline, normalized by L (+ starboard)
y_p	Coordinate in the o direction, from the shaft, normalized by L (+ starboard)
z	Coordinate vertical direction, from waterline, normalized by L (+ up)
z_p	Coordinate in the p direction, from the shaft, normalized by L (+ up)
α	Hull pitch angle (+ bow up)
θ_2	Angle between measured velocity component 2 and z axis
θ_3	Angle between measured velocity component 3 and z axis

Introduction

In order to design a propeller for this hull, the nominal wakes at the starboard propeller planes were measured using LDV. The model conditions and the measurement apparatus will be described in the next sections.

Experimental Apparatus

Probes and Strut

The LDV system consisted of two TSI Model 9832 fiber-optic probes attached to each other on a streamlined strut as shown in Figs. A1 and A2. The probes were mounted rigidly together on the strut in order to keep the measurement volumes aligned. In order to measure at different points in the flow, the probes could be translated in a plane perpendicular to the model axis as a unit.

The upper probe in Fig. A1 used the green (514.5 nm) and blue (488 nm) beams of an argon-ion laser to measure two components of velocity , U_1 and U_2, and the lower probe used the violet (476.5 nm) beams of the laser to measure a third component, U_3. The probes are oriented with their axes parallel to the flow direction (the x axis), and have prisms at the front lens to deflect the beams by 90°. The probes have 50 mm beam spacing and 500 mm focal length (air) lenses. Each probe has an elliptical probe volume with a major axis of 2.0 mm and both minor axes of 0.01 mm. The probe volumes are approximately 620 mm from the probe centerlines in water.

The fringe spacing for the green, blue, and violet beams was 5.266μm, 4.991μm, and 4.872μm, respectively. The probes were oriented so that the green channel measured the axial component of velocity, U_1, the blue channel measured a velocity component U_2 perpendicular to the x axis and at 19.90° to the z axis, and the violet channel measured a velocity component U_3 perpendicular to the x axis and at 63.60° to the z axis. These angles were designed to give maximum access to the flowfield while keeping the strut and probes as far from the model as possible. The relative distance from the strut to the hull is illustrated in Fig. A3.

The strut consisted of 2 × 4 inch aluminum extrusions bolted together in an L shape. On the leading and trailing edges of the strut, 4-inch long double-circular-arc fairings of renshape were attached. These fairings had interior passages to pass the probe cables. A 6 × 0.72 inch streamlined brace was attached at a 45° angle between the two legs of the strut to provide extra rigidity.

Signal Processing

Doppler signals were analyzed with a TSI Model IFA 655 Digital Burst Correlator. The processor performs a 256-sample, double-clipped, autocorrelation on each doppler burst, allowing the measurement of

velocity even when the signal-to-noise ratio is low. In order to maximize data rate, the processors were operated in the random mode.

Seeding

The flow about the hull was seeded with 1500-grit silicon carbide powder. The powder was mixed into a slurry with water and injected through five 0.1-inch diameter taps in the hull at $x/L = 0.2$.

Traverse

The strut assembly was attached to the carriage through a two-component, computer controlled traverse. The traverse sat on the carriage, above the water level. The traverse was powered by two stepper motors attached to 5-thread-per-inch lead screws. Position was determined by rotary encoders mounted to the stepper motors.

The traverse could move the probes in the y and z directions. Positioning in the x direction was achieved by manually moving the hull on the center rail of the carriage. The range of movement in the y direction was approximately 19 inches, and the in the z direction the measurement volume could be positioned to approximately 20 inches below the water surface.

Experimental Procedure

At each point in the flow, measurements were obtained for 4 seconds. In this time between 1000 and 8000 velocity realizations were recorded for each velocity components. Data rate varied from point to point due to the density of seed in the flow. Data rate was lowest on the violet channel due to the lower power of the beams. During each carriage pass, the probe assembly was moved to different positions under computer control. Between 6 and 20 points could be obtained in each pass, depending on carriage speed.

Position of the measurement location was determined by aligning to a reference mark on the hull. At each axial location the hull was positioned fore and aft to bring the reference mark and the plane of the laser beams into coincidence, and then adjusted for the proper dynamic sinkage and trim for the test speed. Once the hull was locked onto the rail, the traverse was then moved in the y and z directions to bring the beam crossing onto the mark.

For each shaft, two grids of points were measured. A circular grid of 289 points centered on the shaft was measured to a radius of 1.1 times the propeller radius. A rectangular grid of $21 \times 9 = 189$ points was measured in the vicinity of the shaft and strut wakes to better resolve those features.

Measurement Conditions

Measurements were made at 6.16 knots, which corresponded to a full-scale speed of 36 knots. Measurements were taken with the BSS Gooseneck bulb, with the model fully appended and at design draft. The model was fixed at the correct dynamic sinkage and trim for this condition. The model was unpropelled, with 1.5 inch long dummy hubs in place of the propellers. These hubs were shorter than the standard propeller hubs so that unobstructed measurements could be made just aft of the truncated dummy hubs, at the nominal propeller plane.

Measurements were made in a plane perpendicular to the direction of model travel. The measurement plane was therefore not perpendicular to the shaft, and the measurements were projected onto a plane perpendicular to the shaft as described in the next section.

Data Reduction

Coordinate Transformations: Measured to World

Three components of velocity, U_1, U_2, and U_3, were measured with the present system, but the components were not aligned with the x, y, and z world axes, nor were they perpendicular. This is illustrated in Fig. A1. The relation between the measured components and the world axes defined by the angles of the two probe axes to the horizontal, θ_2 and θ_3. These angles are 19.90° and 63.60° , respectively. The measured velocities are transformed to the world coordinates by

$$U_x = U_1 \tag{A1}$$

$$U_y = \frac{-U_2 \cos\theta_3 + U_3 \cos\theta_2}{\sin(\theta_3 - \theta_2)} \tag{A2}$$

$$U_z = \frac{U_2 \sin\theta_3 - U_3 \sin\theta_2}{\sin(\theta_3 - \theta_2)} \tag{A3}$$

Coordinate Transformations: World to Shaft Aligned

The measured velocities are in a plane perpendicular to the direction of model travel. To perform an analysis of the flowfield for propeller design, the measurement plane should be perpendicular to the shaft, and the coordinate system should be aligned with the shaft. In order to align the measurements to the shaft, the following angles are considered: the shaft incline, i, the model pitch, α, and the shaft toe, t. For this model, the shaft incline is 2.3°, and the pitch for these tests was –0.24° (bow down). The inner shaft had zero toe, while the outboard shaft had 2.5° toe (toe out).

To project the measurements onto the plane perpendicular to the shaft, the measured points are projected in the direction of the shaft to the propeller-plane coordinates y_p and z_p by:

$$y_p = y\left[1-\cos^2\theta_a(1-\cos a)\right] - z\sin\theta_a\cos\theta_a(1-\cos a) \tag{A4}$$

$$z_p = -y\sin\theta_a\cos\theta_a(1-\cos a) + z\left[1-\sin^2\theta_a(1-\cos a)\right] \tag{A5}$$

where

$$a = \sqrt{t^2 + (i+\alpha)^2} \tag{A6}$$

$$\theta_a = -\frac{i+\alpha}{t} \tag{A7}$$

Note that for this transform, y, z, y_p and z_p are zero at the shaft centerline.

The x, y and z velocities are then converted to the shaft-aligned s, o, and p velocities by

$$\begin{bmatrix} U_s \\ U_o \\ U_p \end{bmatrix} = \begin{bmatrix} U_x \\ U_y \\ U_z \end{bmatrix} \begin{bmatrix} \cos i_r \cos t & \cos i_r \sin t & -\sin i_r \\ -\sin t & \cos t & 0 \\ \sin i_r \cos t & \sin i_r \sin t & \cos i_r \end{bmatrix} \quad \text{with} \quad i_r = i+\alpha \tag{A8}$$

where the s-direction is along the shaft (+ downstream), the o-direction is in the horizontal plane, perpendicular to the shaft (+ starboard), and the p-direction is in the vertical plane, perpendicular to the shaft (+ up). The o and p velocities can then be converted to the radial and tangential velocities by the usual means.

Strut Interference Corrections

Although the measurement volume was some distance from the probes and strut, there was still some disturbance of the measured flow by the hardware. This disturbance is the result of flow being deflected by the probes and strut, and from waves generated by the probes and strut. Due to the free surface, the effect is a function both of carriage speed and measurement depth. The disturbance was quantified by measuring the water velocity with no model attached. If there is no disturbance of the flow, U_1 should measure the carriage speed, and U_2 and U_3 should be zero. A correction to bring the no-model velocities to their ideal values was calculated. The corrections are:

$$U_{x\,corrected} = \frac{U_{x\,raw}}{0.994} \tag{A9}$$

$$U_{y\,corrected} = U_{y\,raw} + U_{x\,corrected}\left(-0.009 - z\cdot 2.6\times 10^{-5}\right) \tag{A10}$$

$$U_{z\,corrected} = U_{z\,raw} + U_{x\,corrected}\left(0.001 - z^2\cdot 3.6\times 10^{-5}\right) \tag{A11}$$

where z is the distance below the undisturbed water surface, in inches, and the velocities are normalized by model speed. The resultant corrections are small — generally less than 1% of model speed. These corrections are applied to all measurements presented here.

Measurement Uncertainty

The primary source of measurement uncertainty is flow fluctuations which occur on time scales which are significant in comparison to the necessarily finite measurement time. These long-scale fluctuations result in an uncertainty in the measured velocity of approximately $0.007U_\infty$ in the shaft wake region, and approximately $0.005U_\infty$ in the rest of the flow field. Angular uncertainty is approximately 0.5°.

Results

Velocity Fields

The measured velocities at the outboard shaft, converted to shaft-oriented coordinates and projected onto the propeller plane, are shown in Fig. A4. Plotted for reference in this figure are two black circles which represent the hub and propeller tip diameters. The color contours represent the magnitude of the velocity in the shaft direction, U_s, and the vectors represent the velocities perpendicular to U_s. The measurement locations are at the tail of each vector. The measurements were made in two overlapping grids — one circular and one rectangular — as shown in Fig. A5. The circular grid provided information on the flow across the propeller disc, while the rectangular grid provided increased spatial resolution in the region of the shaft and strut wakes.

The outboard-shaft nominal wake, shown in Fig. A4, is relatively uniform over most of the disk, with U_s equal to approximately 0.98 U_∞, U_p equal to approximately 0.08 U_∞, and U_o equal to approximately -0.07 U_∞. The regions where this does not hold are in the hub wake, where the streamwise velocity is very much lower, and to the upper inboard side of the hub, where the shaft and strut wakes affect the flow. The strut wakes are thin and not very strong. They can be seen a little more distinctly in Fig. A6, the plot of the rms velocity, q. The inboard strut wake is difficult to distinguish from the shaft wake.

The inboard-shaft nominal wake velocities is shown in Fig. A7, and the corresponding rms velocity fluctuations are shown in Fig. A8. The inboard wake is also relatively uniform over most of the disk, with U_s equal to approximately 0.98 U_∞, U_p equal to approximately 0.08 U_∞, and U_o equal to approximately -0.01 U_∞ in the freestream. Since the inboard shaft is not toed out, the shaft wake is nearly vertical. The strut wakes cannot be easily distinguished from the shaft wake.

The velocity fields were used to determine the average flow near the propeller tip in the event that a ducted propeller would be designed. The average flow velocities and angles were calculated for the region from $0.80 \leq r/R \leq 1.05$. The results of these calculations are shown in Table A.

Circumferential Cuts and Harmonic Content

In order to perform a harmonic analysis on the nominal wake, the measured data was interpolated onto a 22 × 129 circular grid as shown in Fig. A9. In this figure only 1/4th of the vectors are plotted for clarity. Even though the interpolated grid allows for the computation of up to the 63rd harmonic, the higher harmonics are only valid at the outer radii, since at the inner radii the 129 circumferential points were interpolated from a sparser number of measured points.

The interpolated circular grid allows the velocity profiles to be extracted along any given circumference. The circumferential average velocity at each radius is shown in Table A2 and in Fig. A10. These profiles are plotted at r/R = 0.5, 0.7, 0.9, and 1.0 for both inner and outer shafts in Figs. A11 – A26. Also plotted with the velocity profiles are the results of the harmonic analysis of the velocity profiles. The results of the harmonic analysis are tabulated in Tables A – A.

Table A1. Model 5653-3 Nominal Wake LDV measurements, outboard shaft

Model 5653 Nominal Wake LDV Measurements Outboard Shaft

r/R = 0.5

◊	Us	Ut	Ur
-180.0	0.987	-0.093	-0.071
-177.2	0.988	-0.089	-0.074
-174.4	0.988	-0.085	-0.076
-171.6	0.988	-0.081	-0.078
-168.8	0.988	-0.077	-0.081
-165.9	0.988	-0.072	-0.082
-163.1	0.988	-0.067	-0.084
-160.3	0.988	-0.063	-0.086
-157.5	0.988	-0.058	-0.088
-154.7	0.989	-0.054	-0.089
-151.9	0.989	-0.049	-0.090
-149.1	0.989	-0.044	-0.092
-146.3	0.989	-0.039	-0.093
-143.4	0.989	-0.034	-0.094
-140.6	0.989	-0.030	-0.094
-137.8	0.989	-0.025	-0.095
-135.0	0.989	-0.020	-0.095
-132.2	0.989	-0.015	-0.095
-129.4	0.989	-0.010	-0.095
-126.6	0.989	-0.006	-0.095
-123.8	0.989	-0.001	-0.095
-120.9	0.990	0.004	-0.094
-118.1	0.990	0.009	-0.093
-115.3	0.990	0.014	-0.092
-112.5	0.990	0.018	-0.091
-109.7	0.990	0.022	-0.090
-106.9	0.990	0.026	-0.088
-104.1	0.990	0.031	-0.086
-101.3	0.989	0.035	-0.085
-98.4	0.990	0.039	-0.083
-95.6	0.990	0.043	-0.081
-92.8	0.990	0.046	-0.078
-90.0	0.989	0.050	-0.076

r/R = 0.5

◊	Us	Ut	Ur
-87.2	0.990	0.054	-0.073
-84.4	0.990	0.057	-0.071
-81.6	0.990	0.060	-0.068
-78.8	0.990	0.062	-0.066
-75.9	0.990	0.065	-0.062
-73.1	0.990	0.067	-0.059
-70.3	0.991	0.069	-0.056
-67.5	0.990	0.070	-0.053
-64.7	0.991	0.073	-0.050
-61.9	0.991	0.074	-0.046
-59.1	0.991	0.075	-0.043
-56.3	0.991	0.076	-0.039
-53.4	0.992	0.076	-0.036
-50.6	0.992	0.077	-0.033
-47.8	0.992	0.076	-0.029
-45.0	0.992	0.074	-0.025
-42.2	0.992	0.074	-0.021
-39.4	0.993	0.072	-0.018
-36.6	0.993	0.070	-0.014
-33.8	0.993	0.068	-0.010
-30.9	0.993	0.066	-0.006
-28.1	0.993	0.063	-0.002
-25.3	0.993	0.060	0.001
-22.5	0.992	0.056	0.005
-19.7	0.991	0.053	0.007
-16.9	0.984	0.046	0.005
-14.1	0.978	0.041	0.003
-11.3	0.965	0.034	-0.004
-8.4	0.951	0.028	-0.013
-5.6	0.942	0.024	-0.022
-2.8	0.938	0.021	-0.031
0.0	0.944	0.020	-0.039

r/R = 0.5

◊	Us	Ut	Ur
2.8	0.949	0.020	-0.044
5.6	0.949	0.021	-0.049
8.4	0.944	0.021	-0.050
11.3	0.934	0.022	-0.051
14.1	0.926	0.024	-0.051
16.9	0.916	0.025	-0.050
19.7	0.908	0.028	-0.048
22.5	0.900	0.030	-0.046
25.3	0.894	0.031	-0.044
28.1	0.887	0.032	-0.040
30.9	0.881	0.032	-0.038
33.8	0.872	0.030	-0.032
36.6	0.859	0.026	-0.024
39.4	0.846	0.021	-0.015
42.2	0.827	0.016	-0.003
45.0	0.815	0.010	0.010
47.8	0.813	0.003	0.025
50.6	0.820	-0.006	0.041
53.4	0.851	-0.018	0.050
56.3	0.886	-0.030	0.055
59.1	0.917	-0.041	0.060
61.9	0.947	-0.052	0.063
64.7	0.974	-0.064	0.064
67.5	0.982	-0.071	0.062
70.3	0.983	-0.080	0.059
73.1	0.987	-0.087	0.056
75.9	0.991	-0.094	0.054
78.8	0.989	-0.095	0.050
81.6	0.990	-0.102	0.046
84.4	0.991	-0.107	0.043
87.2	0.991	-0.111	0.040
90.0	1.000	-0.116	0.040

r/R = 0.5

◊	Us	Ut	Ur
92.8	0.990	-0.119	0.034
95.6	0.990	-0.123	0.031
98.4	0.990	-0.126	0.028
101.3	0.990	-0.126	0.025
104.1	0.990	-0.130	0.022
106.9	0.989	-0.132	0.019
109.7	0.990	-0.134	0.015
112.5	0.989	-0.134	0.012
115.3	0.989	-0.136	0.009
118.1	0.989	-0.137	0.006
120.9	0.989	-0.137	0.002
123.8	0.989	-0.138	-0.002
126.6	0.989	-0.139	-0.006
129.4	0.989	-0.138	-0.009
132.2	0.989	-0.138	-0.013
135.0	0.988	-0.135	-0.017
137.8	0.989	-0.136	-0.021
140.6	0.989	-0.135	-0.024
143.4	0.988	-0.133	-0.028
146.3	0.988	-0.131	-0.032
149.1	0.988	-0.129	-0.036
151.9	0.988	-0.127	-0.039
154.7	0.988	-0.124	-0.043
157.5	0.987	-0.121	-0.047
160.3	0.988	-0.119	-0.050
163.1	0.988	-0.115	-0.053
165.9	0.988	-0.112	-0.057
168.8	0.988	-0.108	-0.060
171.6	0.988	-0.105	-0.063
174.4	0.988	-0.101	-0.066
177.2	0.988	-0.097	-0.069
180.0	0.987	-0.093	-0.071

Table A1. Model 5653-3 Nominal Wake LDV measurements, outboard shaft (continued)

Model 5653 Nominal Wake LDV Measurements Outboard Shaft

r/R = 0.7

≅	Us	Ut	Ur
-180.0	0.982	-0.082	-0.070
-177.2	0.982	-0.079	-0.072
-174.4	0.982	-0.075	-0.074
-171.6	0.982	-0.071	-0.076
-168.8	0.982	-0.067	-0.078
-165.9	0.983	-0.063	-0.081
-163.1	0.982	-0.058	-0.083
-160.3	0.983	-0.054	-0.084
-157.5	0.982	-0.049	-0.085
-154.7	0.982	-0.045	-0.087
-151.9	0.982	-0.041	-0.088
-149.1	0.982	-0.037	-0.089
-146.3	0.982	-0.033	-0.090
-143.4	0.982	-0.028	-0.090
-140.6	0.982	-0.024	-0.091
-137.8	0.982	-0.019	-0.091
-135.0	0.982	-0.014	-0.092
-132.2	0.982	-0.010	-0.092
-129.4	0.982	-0.005	-0.092
-126.6	0.982	-0.001	-0.092
-123.8	0.982	0.003	-0.091
-120.9	0.982	0.008	-0.090
-118.1	0.982	0.012	-0.089
-115.3	0.982	0.017	-0.088
-112.5	0.983	0.021	-0.086
-109.7	0.982	0.025	-0.085
-106.9	0.982	0.029	-0.083
-104.1	0.982	0.032	-0.081
-101.3	0.982	0.036	-0.079
-98.4	0.981	0.040	-0.077
-95.6	0.982	0.044	-0.075
-92.8	0.982	0.047	-0.072
-90.0	0.981	0.051	-0.070

r/R = 0.7

≅	Us	Ut	Ur
-87.2	0.982	0.054	-0.067
-84.4	0.982	0.057	-0.064
-81.6	0.981	0.060	-0.061
-78.8	0.982	0.063	-0.058
-75.9	0.982	0.065	-0.055
-73.1	0.982	0.067	-0.051
-70.3	0.982	0.069	-0.048
-67.5	0.982	0.071	-0.044
-64.7	0.982	0.073	-0.040
-61.9	0.981	0.074	-0.036
-59.1	0.982	0.076	-0.032
-56.3	0.981	0.077	-0.028
-53.4	0.981	0.078	-0.023
-50.6	0.981	0.078	-0.020
-47.8	0.981	0.079	-0.015
-45.0	0.981	0.079	-0.011
-42.2	0.981	0.078	-0.006
-39.4	0.981	0.078	-0.001
-36.6	0.980	0.077	0.004
-33.8	0.980	0.076	0.009
-30.9	0.980	0.074	0.014
-28.1	0.979	0.072	0.019
-25.3	0.979	0.070	0.025
-22.5	0.977	0.067	0.030
-19.7	0.974	0.064	0.036
-16.9	0.969	0.062	0.040
-14.1	0.963	0.058	0.042
-11.3	0.949	0.053	0.040
-8.4	0.929	0.047	0.030
-5.6	0.909	0.038	0.015
-2.8	0.899	0.031	0.003
0.0	0.902	0.028	-0.005

r/R = 0.7

≅	Us	Ut	Ur
2.8	0.893	0.023	-0.011
5.6	0.880	0.019	-0.015
8.4	0.863	0.016	-0.017
11.3	0.848	0.013	-0.019
14.1	0.833	0.010	-0.022
16.9	0.821	0.009	-0.024
19.7	0.817	0.007	-0.024
22.5	0.821	0.004	-0.023
25.3	0.822	0.004	-0.019
28.1	0.828	0.003	-0.013
30.9	0.837	0.001	-0.007
33.8	0.844	-0.003	0.000
36.6	0.847	-0.006	0.008
39.4	0.847	-0.011	0.020
42.2	0.862	-0.018	0.036
45.0	0.882	-0.026	0.052
47.8	0.903	-0.035	0.066
50.6	0.922	-0.044	0.076
53.4	0.938	-0.052	0.083
56.3	0.953	-0.056	0.085
59.1	0.964	-0.061	0.086
61.9	0.972	-0.065	0.087
64.7	0.976	-0.069	0.085
67.5	0.977	-0.074	0.082
70.3	0.978	-0.078	0.079
73.1	0.979	-0.082	0.076
75.9	0.979	-0.086	0.072
78.8	0.979	-0.090	0.069
81.6	0.979	-0.093	0.066
84.4	0.979	-0.096	0.062
87.2	0.979	-0.099	0.058
90.0	0.979	-0.102	0.055

r/R = 0.7

≅	Us	Ut	Ur
92.8	0.979	-0.105	0.050
95.6	0.979	-0.108	0.046
98.4	0.979	-0.110	0.042
101.3	0.980	-0.113	0.037
104.1	0.981	-0.114	0.033
106.9	0.981	-0.115	0.030
109.7	0.982	-0.117	0.025
112.5	0.983	-0.119	0.021
115.3	0.983	-0.120	0.017
118.1	0.983	-0.120	0.013
120.9	0.982	-0.121	0.009
123.8	0.982	-0.121	0.004
126.6	0.981	-0.121	0.000
129.4	0.981	-0.121	-0.004
132.2	0.981	-0.121	-0.008
135.0	0.981	-0.120	-0.012
137.8	0.981	-0.119	-0.017
140.6	0.981	-0.118	-0.021
143.4	0.981	-0.116	-0.025
146.3	0.982	-0.115	-0.029
149.1	0.982	-0.114	-0.032
151.9	0.982	-0.111	-0.036
154.7	0.982	-0.109	-0.040
157.5	0.982	-0.107	-0.044
160.3	0.983	-0.104	-0.047
163.1	0.982	-0.101	-0.051
165.9	0.982	-0.099	-0.054
168.8	0.982	-0.095	-0.058
171.6	0.982	-0.092	-0.061
174.4	0.982	-0.089	-0.064
177.2	0.982	-0.086	-0.067
180.0	0.982	-0.082	-0.070

Table A1. Model 5653-3 Nominal Wake LDV measurements, outboard shaft (continued)

Model 5653 Nominal Wake LDV Measurements Outboard Shaft

r/R = 0.9

ξ	Us	Ut	Ur
-180.0	0.981	-0.076	-0.067
-177.2	0.981	-0.073	-0.070
-174.4	0.982	-0.069	-0.072
-171.6	0.982	-0.065	-0.075
-168.8	0.982	-0.061	-0.077
-165.9	0.983	-0.057	-0.078
-163.1	0.982	-0.053	-0.080
-160.3	0.981	-0.048	-0.082
-157.5	0.980	-0.044	-0.084
-154.7	0.981	-0.041	-0.085
-151.9	0.981	-0.037	-0.086
-149.1	0.981	-0.033	-0.087
-146.3	0.982	-0.028	-0.088
-143.4	0.982	-0.024	-0.089
-140.6	0.982	-0.019	-0.089
-137.8	0.982	-0.014	-0.089
-135.0	0.982	-0.010	-0.089
-132.2	0.982	-0.006	-0.089
-129.4	0.982	-0.002	-0.088
-126.6	0.982	0.002	-0.088
-123.8	0.981	0.007	-0.088
-120.9	0.981	0.011	-0.087
-118.1	0.981	0.015	-0.086
-115.3	0.981	0.019	-0.085
-112.5	0.981	0.022	-0.083
-109.7	0.981	0.027	-0.082
-106.9	0.981	0.031	-0.080
-104.1	0.981	0.035	-0.079
-101.3	0.980	0.038	-0.076
-98.4	0.980	0.041	-0.074
-95.6	0.980	0.045	-0.072
-92.8	0.980	0.048	-0.070
-90.0	0.981	0.052	-0.068

r/R = 0.9

ξ	Us	Ut	Ur
-87.2	0.980	0.055	-0.065
-84.4	0.980	0.058	-0.062
-81.6	0.979	0.061	-0.059
-78.8	0.979	0.063	-0.055
-75.9	0.980	0.066	-0.052
-73.1	0.980	0.069	-0.049
-70.3	0.979	0.071	-0.045
-67.5	0.978	0.073	-0.042
-64.7	0.978	0.075	-0.038
-61.9	0.979	0.076	-0.034
-59.1	0.979	0.078	-0.030
-56.3	0.978	0.080	-0.026
-53.4	0.977	0.081	-0.021
-50.6	0.977	0.082	-0.017
-47.8	0.977	0.082	-0.013
-45.0	0.977	0.082	-0.008
-42.2	0.977	0.083	-0.003
-39.4	0.975	0.083	0.002
-36.6	0.974	0.084	0.008
-33.8	0.972	0.083	0.013
-30.9	0.969	0.082	0.019
-28.1	0.963	0.081	0.024
-25.3	0.956	0.079	0.029
-22.5	0.949	0.077	0.035
-19.7	0.944	0.075	0.041
-16.9	0.939	0.072	0.047
-14.1	0.932	0.068	0.053
-11.3	0.923	0.065	0.054
-8.4	0.900	0.055	0.049
-5.6	0.872	0.046	0.036
-2.8	0.868	0.043	0.027
0.0	0.872	0.040	0.023

r/R = 0.9

ξ	Us	Ut	Ur
2.8	0.863	0.033	0.022
5.6	0.842	0.026	0.017
8.4	0.813	0.020	0.012
11.3	0.781	0.012	0.005
14.1	0.756	0.006	-0.002
16.9	0.733	0.001	-0.009
19.7	0.725	0.001	-0.011
22.5	0.729	0.003	-0.010
25.3	0.745	0.000	-0.005
28.1	0.757	-0.002	0.000
30.9	0.777	-0.003	0.006
33.8	0.802	-0.005	0.012
36.6	0.823	-0.004	0.022
39.4	0.839	-0.006	0.035
42.2	0.856	-0.011	0.051
45.0	0.894	-0.019	0.067
47.8	0.925	-0.029	0.076
50.6	0.945	-0.036	0.082
53.4	0.958	-0.042	0.086
56.3	0.962	-0.048	0.088
59.1	0.967	-0.054	0.090
61.9	0.970	-0.059	0.089
64.7	0.970	-0.063	0.087
67.5	0.972	-0.068	0.085
70.3	0.974	-0.073	0.083
73.1	0.975	-0.077	0.080
75.9	0.975	-0.081	0.076
78.8	0.975	-0.085	0.073
81.6	0.976	-0.088	0.069
84.4	0.976	-0.091	0.065
87.2	0.976	-0.094	0.061
90.0	0.976	-0.097	0.057

r/R = 0.9

ξ	Us	Ut	Ur
92.8	0.976	-0.100	0.054
95.6	0.976	-0.103	0.050
98.4	0.977	-0.105	0.047
101.3	0.977	-0.107	0.042
104.1	0.977	-0.109	0.038
106.9	0.976	-0.110	0.033
109.7	0.977	-0.110	0.029
112.5	0.977	-0.111	0.025
115.3	0.978	-0.112	0.020
118.1	0.978	-0.112	0.016
120.9	0.979	-0.113	0.011
123.8	0.978	-0.113	0.007
126.6	0.977	-0.113	0.003
129.4	0.977	-0.113	-0.002
132.2	0.978	-0.113	-0.007
135.0	0.979	-0.113	-0.011
137.8	0.979	-0.111	-0.015
140.6	0.979	-0.109	-0.019
143.4	0.980	-0.108	-0.022
146.3	0.980	-0.106	-0.027
149.1	0.981	-0.105	-0.031
151.9	0.980	-0.103	-0.034
154.7	0.980	-0.101	-0.038
157.5	0.979	-0.099	-0.041
160.3	0.979	-0.096	-0.045
163.1	0.980	-0.093	-0.048
165.9	0.981	-0.091	-0.052
168.8	0.981	-0.088	-0.056
171.6	0.981	-0.086	-0.059
174.4	0.981	-0.083	-0.062
177.2	0.981	-0.080	-0.064
180.0	0.981	-0.076	-0.067

Table A1. Model 5653-3 Nominal Wake LDV measurements, outboard shaft (continued)

Model 5653 Nominal Wake LDV Measurements Outboard Shaft

r/R = 1.0

ξ	Us	Ut	Ur
-180.0	0.982	-0.074	-0.067
-177.2	0.981	-0.071	-0.069
-174.4	0.980	-0.068	-0.072
-171.6	0.981	-0.063	-0.074
-168.8	0.982	-0.059	-0.076
-165.9	0.982	-0.054	-0.078
-163.1	0.981	-0.050	-0.079
-160.3	0.981	-0.047	-0.081
-157.5	0.981	-0.043	-0.083
-154.7	0.981	-0.040	-0.084
-151.9	0.981	-0.036	-0.086
-149.1	0.982	-0.032	-0.087
-146.3	0.981	-0.027	-0.088
-143.4	0.981	-0.022	-0.087
-140.6	0.981	-0.017	-0.087
-137.8	0.980	-0.013	-0.088
-135.0	0.980	-0.009	-0.088
-132.2	0.981	-0.005	-0.088
-129.4	0.981	-0.001	-0.089
-126.6	0.981	0.003	-0.088
-123.8	0.981	0.007	-0.087
-120.9	0.981	0.011	-0.087
-118.1	0.981	0.015	-0.086
-115.3	0.981	0.018	-0.086
-112.5	0.981	0.022	-0.083
-109.7	0.980	0.026	-0.081
-106.9	0.980	0.030	-0.080
-104.1	0.980	0.034	-0.078
-101.3	0.980	0.038	-0.076
-98.4	0.980	0.042	-0.074
-95.6	0.980	0.045	-0.072
-92.8	0.980	0.048	-0.069
-90.0	0.979	0.051	-0.066

r/R = 1.0

ξ	Us	Ut	Ur
-87.2	0.979	0.055	-0.064
-84.4	0.979	0.058	-0.061
-81.6	0.978	0.061	-0.058
-78.8	0.978	0.064	-0.055
-75.9	0.978	0.067	-0.051
-73.1	0.978	0.069	-0.048
-70.3	0.978	0.072	-0.045
-67.5	0.977	0.074	-0.041
-64.7	0.977	0.076	-0.037
-61.9	0.977	0.077	-0.033
-59.1	0.977	0.078	-0.029
-56.3	0.976	0.080	-0.025
-53.4	0.976	0.081	-0.021
-50.6	0.976	0.083	-0.016
-47.8	0.976	0.084	-0.012
-45.0	0.977	0.085	-0.007
-42.2	0.976	0.085	-0.002
-39.4	0.975	0.086	0.002
-36.6	0.972	0.087	0.007
-33.8	0.968	0.087	0.012
-30.9	0.961	0.087	0.017
-28.1	0.953	0.086	0.023
-25.3	0.943	0.084	0.028
-22.5	0.935	0.081	0.035
-19.7	0.928	0.078	0.042
-16.9	0.918	0.075	0.048
-14.1	0.908	0.071	0.055
-11.3	0.896	0.065	0.058
-8.4	0.873	0.060	0.055
-5.6	0.839	0.050	0.042
-2.8	0.836	0.045	0.030
0.0	0.839	0.041	0.028

r/R = 1.0

ξ	Us	Ut	Ur
2.8	0.837	0.038	0.031
5.6	0.819	0.032	0.032
8.4	0.790	0.026	0.028
11.3	0.758	0.018	0.017
14.1	0.724	0.009	0.006
16.9	0.703	0.007	0.000
19.7	0.684	0.000	-0.005
22.5	0.682	0.001	-0.004
25.3	0.685	0.005	-0.002
28.1	0.711	0.003	0.004
30.9	0.736	0.002	0.013
33.8	0.766	0.000	0.023
36.6	0.796	-0.002	0.031
39.4	0.815	-0.005	0.040
42.2	0.824	-0.010	0.054
45.0	0.862	-0.016	0.072
47.8	0.898	-0.024	0.078
50.6	0.925	-0.032	0.084
53.4	0.935	-0.039	0.086
56.3	0.945	-0.044	0.086
59.1	0.954	-0.050	0.086
61.9	0.957	-0.056	0.086
64.7	0.963	-0.062	0.087
67.5	0.966	-0.066	0.085
70.3	0.971	-0.071	0.083
73.1	0.972	-0.075	0.080
75.9	0.972	-0.080	0.077
78.8	0.973	-0.083	0.074
81.6	0.974	-0.086	0.070
84.4	0.974	-0.089	0.066
87.2	0.974	-0.092	0.063
90.0	0.975	-0.096	0.059

r/R = 1.0

ξ	Us	Ut	Ur
92.8	0.975	-0.098	0.055
95.6	0.976	-0.101	0.051
98.4	0.976	-0.103	0.047
101.3	0.976	-0.105	0.043
104.1	0.976	-0.106	0.038
106.9	0.976	-0.107	0.034
109.7	0.975	-0.108	0.030
112.5	0.976	-0.110	0.026
115.3	0.977	-0.111	0.021
118.1	0.977	-0.111	0.016
120.9	0.977	-0.111	0.012
123.8	0.977	-0.111	0.007
126.6	0.976	-0.110	0.002
129.4	0.976	-0.110	-0.003
132.2	0.977	-0.109	-0.007
135.0	0.977	-0.109	-0.011
137.8	0.978	-0.108	-0.015
140.6	0.979	-0.107	-0.018
143.4	0.979	-0.105	-0.022
146.3	0.980	-0.105	-0.026
149.1	0.980	-0.103	-0.030
151.9	0.980	-0.101	-0.034
154.7	0.980	-0.099	-0.038
157.5	0.979	-0.097	-0.042
160.3	0.979	-0.095	-0.045
163.1	0.980	-0.092	-0.049
165.9	0.981	-0.089	-0.052
168.8	0.982	-0.086	-0.055
171.6	0.981	-0.083	-0.058
174.4	0.981	-0.080	-0.061
177.2	0.981	-0.077	-0.064
180.0	0.982	-0.074	-0.067

Table A2. Model 5653-3 Nominal Wake LDV measurements, inboard shaft

Model 5653 Nominal Wake LDV Measurements Inboard Shaft

r/R = 0.5

¬	Us	Ut	Ur
-180.0	0.987	-0.019	-0.075
-177.2	0.987	-0.015	-0.076
-174.4	0.987	-0.011	-0.076
-171.6	0.987	-0.007	-0.077
-168.8	0.986	-0.003	-0.077
-165.9	0.986	0.001	-0.077
-163.1	0.986	0.005	-0.077
-160.3	0.986	0.009	-0.077
-157.5	0.985	0.012	-0.077
-154.7	0.986	0.016	-0.077
-151.9	0.986	0.020	-0.076
-149.1	0.986	0.024	-0.075
-146.3	0.985	0.028	-0.075
-143.4	0.986	0.032	-0.074
-140.6	0.986	0.036	-0.073
-137.8	0.986	0.039	-0.072
-135.0	0.985	0.043	-0.071
-132.2	0.985	0.046	-0.069
-129.4	0.985	0.050	-0.068
-126.6	0.985	0.053	-0.066
-123.8	0.985	0.056	-0.065
-120.9	0.985	0.059	-0.062
-118.1	0.985	0.062	-0.060
-115.3	0.985	0.065	-0.058
-112.5	0.984	0.068	-0.056
-109.7	0.985	0.071	-0.054
-106.9	0.984	0.073	-0.051
-104.1	0.984	0.075	-0.048
-101.3	0.984	0.077	-0.046
-98.4	0.985	0.080	-0.043
-95.6	0.984	0.082	-0.040
-92.8	0.984	0.083	-0.037
-90.0	0.983	0.084	-0.034

r/R = 0.5

¬	Us	Ut	Ur
-87.2	0.984	0.086	-0.031
-84.4	0.984	0.087	-0.028
-81.6	0.984	0.088	-0.025
-78.8	0.983	0.088	-0.021
-75.9	0.983	0.088	-0.018
-73.1	0.983	0.088	-0.014
-70.3	0.983	0.088	-0.011
-67.5	0.983	0.086	-0.008
-64.7	0.983	0.086	-0.005
-61.9	0.982	0.084	-0.002
-59.1	0.981	0.082	0.001
-56.3	0.980	0.080	0.004
-53.4	0.979	0.078	0.006
-50.6	0.978	0.075	0.009
-47.8	0.976	0.071	0.011
-45.0	0.975	0.067	0.014
-42.2	0.974	0.064	0.016
-39.4	0.973	0.060	0.017
-36.6	0.972	0.056	0.019
-33.8	0.971	0.052	0.022
-30.9	0.971	0.048	0.024
-28.1	0.968	0.041	0.024
-25.3	0.963	0.035	0.022
-22.5	0.948	0.029	0.017
-19.7	0.932	0.024	0.009
-16.9	0.912	0.018	-0.002
-14.1	0.895	0.014	-0.012
-11.3	0.883	0.012	-0.022
-8.4	0.873	0.013	-0.031
-5.6	0.867	0.015	-0.036
-2.8	0.864	0.017	-0.039
0.0	0.859	0.018	-0.041

r/R = 0.5

¬	Us	Ut	Ur
2.8	0.857	0.018	-0.042
5.6	0.854	0.019	-0.043
8.4	0.851	0.019	-0.041
11.3	0.850	0.019	-0.038
14.1	0.846	0.018	-0.034
16.9	0.843	0.016	-0.029
19.7	0.837	0.014	-0.021
22.5	0.835	0.012	-0.014
25.3	0.832	0.008	-0.008
28.1	0.834	0.005	-0.004
30.9	0.845	0.000	0.000
33.8	0.868	-0.007	0.004
36.6	0.899	-0.015	0.007
39.4	0.927	-0.024	0.010
42.2	0.952	-0.032	0.012
45.0	0.969	-0.041	0.014
47.8	0.979	-0.047	0.015
50.6	0.983	-0.052	0.014
53.4	0.985	-0.057	0.013
56.3	0.986	-0.062	0.011
59.1	0.988	-0.067	0.009
61.9	0.989	-0.071	0.007
64.7	0.990	-0.075	0.005
67.5	0.991	-0.077	0.003
70.3	0.990	-0.080	0.000
73.1	0.991	-0.083	-0.002
75.9	0.991	-0.085	-0.005
78.8	0.991	-0.086	-0.008
81.6	0.992	-0.089	-0.011
84.4	0.993	-0.091	-0.014
87.2	0.993	-0.091	-0.016
90.0	0.997	-0.091	-0.017

r/R = 0.5

¬	Us	Ut	Ur
92.8	0.993	-0.093	-0.022
95.6	0.993	-0.093	-0.024
98.4	0.993	-0.093	-0.027
101.3	0.992	-0.092	-0.028
104.1	0.992	-0.092	-0.031
106.9	0.992	-0.092	-0.033
109.7	0.992	-0.091	-0.035
112.5	0.992	-0.089	-0.037
115.3	0.992	-0.089	-0.039
118.1	0.992	-0.087	-0.041
120.9	0.992	-0.085	-0.043
123.8	0.991	-0.083	-0.046
126.6	0.992	-0.081	-0.048
129.4	0.991	-0.079	-0.050
132.2	0.991	-0.076	-0.052
135.0	0.990	-0.073	-0.054
137.8	0.990	-0.070	-0.056
140.6	0.990	-0.068	-0.058
143.4	0.990	-0.065	-0.059
146.3	0.989	-0.061	-0.061
149.1	0.989	-0.058	-0.063
151.9	0.989	-0.055	-0.064
154.7	0.989	-0.052	-0.066
157.5	0.988	-0.048	-0.067
160.3	0.989	-0.045	-0.069
163.1	0.988	-0.042	-0.070
165.9	0.988	-0.038	-0.071
168.8	0.988	-0.034	-0.072
171.6	0.988	-0.030	-0.073
174.4	0.988	-0.026	-0.074
177.2	0.988	-0.023	-0.075
180.0	0.987	-0.019	-0.075

Table A2. Model 5653-3 Nominal Wake LDV measurements, inboard shaft (continued)

Model 5653 Nominal Wake LDV Measurements Inboard Shaft

r/R = 0.7

ξ	Us	Ut	Ur
-180.0	0.982	-0.017	-0.070
-177.2	0.982	-0.013	-0.071
-174.4	0.982	-0.010	-0.071
-171.6	0.982	-0.006	-0.072
-168.8	0.982	-0.003	-0.072
-165.9	0.982	0.000	-0.073
-163.1	0.982	0.003	-0.073
-160.3	0.982	0.007	-0.073
-157.5	0.982	0.010	-0.073
-154.7	0.982	0.014	-0.072
-151.9	0.981	0.017	-0.072
-149.1	0.981	0.021	-0.071
-146.3	0.981	0.025	-0.071
-143.4	0.981	0.028	-0.070
-140.6	0.980	0.032	-0.069
-137.8	0.980	0.035	-0.068
-135.0	0.980	0.039	-0.066
-132.2	0.980	0.042	-0.065
-129.4	0.981	0.045	-0.064
-126.6	0.981	0.048	-0.062
-123.8	0.981	0.051	-0.061
-120.9	0.981	0.054	-0.059
-118.1	0.981	0.057	-0.057
-115.3	0.980	0.060	-0.055
-112.5	0.980	0.063	-0.053
-109.7	0.980	0.065	-0.050
-106.9	0.979	0.068	-0.047
-104.1	0.979	0.070	-0.045
-101.3	0.978	0.072	-0.041
-98.4	0.978	0.074	-0.038
-95.6	0.978	0.077	-0.035
-92.8	0.978	0.079	-0.031
-90.0	0.977	0.080	-0.027

r/R = 0.7

ξ	Us	Ut	Ur
-87.2	0.977	0.081	-0.024
-84.4	0.976	0.082	-0.020
-81.6	0.975	0.083	-0.016
-78.8	0.975	0.083	-0.012
-75.9	0.975	0.083	-0.008
-73.1	0.974	0.082	-0.004
-70.3	0.974	0.082	0.000
-67.5	0.974	0.081	0.004
-64.7	0.973	0.080	0.008
-61.9	0.971	0.079	0.012
-59.1	0.971	0.077	0.016
-56.3	0.969	0.075	0.019
-53.4	0.967	0.072	0.023
-50.6	0.963	0.070	0.026
-47.8	0.959	0.067	0.029
-45.0	0.956	0.064	0.032
-42.2	0.953	0.060	0.034
-39.4	0.949	0.056	0.037
-36.6	0.945	0.052	0.039
-33.8	0.942	0.048	0.041
-30.9	0.937	0.045	0.044
-28.1	0.932	0.041	0.046
-25.3	0.927	0.036	0.047
-22.5	0.917	0.031	0.046
-19.7	0.895	0.023	0.038
-16.9	0.874	0.017	0.027
-14.1	0.851	0.014	0.011
-11.3	0.840	0.012	-0.001
-8.4	0.833	0.012	-0.010
-5.6	0.827	0.012	-0.014
-2.8	0.818	0.012	-0.017
0.0	0.808	0.012	-0.017

r/R = 0.7

ξ	Us	Ut	Ur
2.8	0.805	0.011	-0.019
5.6	0.805	0.011	-0.019
8.4	0.811	0.009	-0.017
11.3	0.819	0.008	-0.013
14.1	0.830	0.007	-0.008
16.9	0.840	0.005	-0.001
19.7	0.852	0.004	0.004
22.5	0.864	0.001	0.008
25.3	0.873	0.001	0.014
28.1	0.880	0.000	0.020
30.9	0.884	-0.003	0.026
33.8	0.898	-0.008	0.032
36.6	0.919	-0.016	0.038
39.4	0.941	-0.026	0.042
42.2	0.952	-0.033	0.044
45.0	0.958	-0.038	0.043
47.8	0.963	-0.042	0.042
50.6	0.967	-0.047	0.040
53.4	0.970	-0.052	0.037
56.3	0.971	-0.056	0.035
59.1	0.973	-0.060	0.032
61.9	0.975	-0.064	0.029
64.7	0.976	-0.068	0.026
67.5	0.976	-0.071	0.022
70.3	0.977	-0.074	0.019
73.1	0.978	-0.076	0.015
75.9	0.979	-0.078	0.011
78.8	0.979	-0.080	0.007
81.6	0.980	-0.081	0.003
84.4	0.981	-0.082	-0.001
87.2	0.981	-0.083	-0.005
90.0	0.982	-0.083	-0.008

r/R = 0.7

ξ	Us	Ut	Ur
92.8	0.983	-0.083	-0.011
95.6	0.984	-0.083	-0.014
98.4	0.984	-0.082	-0.016
101.3	0.985	-0.082	-0.018
104.1	0.985	-0.082	-0.021
106.9	0.985	-0.080	-0.024
109.7	0.986	-0.080	-0.027
112.5	0.986	-0.079	-0.030
115.3	0.986	-0.078	-0.032
118.1	0.985	-0.076	-0.035
120.9	0.985	-0.074	-0.037
123.8	0.985	-0.072	-0.040
126.6	0.984	-0.070	-0.043
129.4	0.985	-0.069	-0.045
132.2	0.985	-0.067	-0.047
135.0	0.985	-0.065	-0.049
137.8	0.985	-0.062	-0.051
140.6	0.985	-0.059	-0.053
143.4	0.985	-0.056	-0.055
146.3	0.984	-0.053	-0.057
149.1	0.984	-0.051	-0.058
151.9	0.984	-0.047	-0.060
154.7	0.984	-0.045	-0.062
157.5	0.984	-0.042	-0.063
160.3	0.984	-0.039	-0.064
163.1	0.984	-0.036	-0.065
165.9	0.983	-0.033	-0.067
168.8	0.983	-0.030	-0.068
171.6	0.982	-0.027	-0.069
174.4	0.982	-0.024	-0.070
177.2	0.982	-0.020	-0.070
180.0	0.982	-0.017	-0.070

Table A2. Model 5653-3 Nominal Wake LDV measurements, inboard shaft (continued)

Model 5653 Nominal Wake LDV Measurements — Inboard Shaft

r/R = 0.9

θ	Us	Ut	Ur
-180.0	0.982	-0.015	-0.068
-177.2	0.982	-0.012	-0.069
-174.4	0.982	-0.009	-0.069
-171.6	0.981	-0.006	-0.070
-168.8	0.981	-0.003	-0.070
-165.9	0.982	0.000	-0.070
-163.1	0.981	0.003	-0.070
-160.3	0.981	0.006	-0.069
-157.5	0.980	0.010	-0.069
-154.7	0.980	0.013	-0.069
-151.9	0.980	0.017	-0.068
-149.1	0.980	0.020	-0.068
-146.3	0.979	0.023	-0.067
-143.4	0.978	0.026	-0.067
-140.6	0.978	0.028	-0.066
-137.8	0.979	0.031	-0.065
-135.0	0.979	0.034	-0.064
-132.2	0.978	0.037	-0.063
-129.4	0.978	0.041	-0.062
-126.6	0.978	0.044	-0.061
-123.8	0.978	0.047	-0.059
-120.9	0.977	0.050	-0.058
-118.1	0.977	0.053	-0.057
-115.3	0.977	0.057	-0.055
-112.5	0.978	0.060	-0.053
-109.7	0.977	0.063	-0.050
-106.9	0.977	0.066	-0.048
-104.1	0.977	0.069	-0.045
-101.3	0.977	0.072	-0.041
-98.4	0.976	0.074	-0.037
-95.6	0.976	0.077	-0.033
-92.8	0.975	0.079	-0.029
-90.0	0.975	0.081	-0.025

r/R = 0.9

θ	Us	Ut	Ur
-87.2	0.974	0.082	-0.021
-84.4	0.973	0.083	-0.016
-81.6	0.973	0.083	-0.012
-78.8	0.973	0.084	-0.007
-75.9	0.973	0.084	-0.003
-73.1	0.972	0.084	0.002
-70.3	0.972	0.083	0.006
-67.5	0.971	0.082	0.010
-64.7	0.970	0.081	0.014
-61.9	0.968	0.079	0.018
-59.1	0.967	0.077	0.022
-56.3	0.966	0.074	0.026
-53.4	0.965	0.072	0.030
-50.6	0.958	0.068	0.033
-47.8	0.949	0.065	0.036
-45.0	0.940	0.061	0.039
-42.2	0.932	0.057	0.043
-39.4	0.923	0.054	0.046
-36.6	0.915	0.051	0.048
-33.8	0.909	0.048	0.050
-30.9	0.903	0.045	0.052
-28.1	0.897	0.042	0.055
-25.3	0.890	0.039	0.058
-22.5	0.881	0.036	0.059
-19.7	0.858	0.028	0.052
-16.9	0.831	0.019	0.041
-14.1	0.808	0.015	0.027
-11.3	0.798	0.014	0.016
-8.4	0.782	0.011	0.008
-5.6	0.765	0.009	0.001
-2.8	0.747	0.011	-0.003
0.0	0.733	0.013	-0.006

r/R = 0.9

θ	Us	Ut	Ur
2.8	0.731	0.013	-0.009
5.6	0.735	0.012	-0.008
8.4	0.743	0.012	-0.005
11.3	0.754	0.012	-0.002
14.1	0.764	0.011	0.003
16.9	0.777	0.012	0.007
19.7	0.796	0.009	0.014
22.5	0.821	0.006	0.022
25.3	0.845	0.002	0.029
28.1	0.859	-0.001	0.035
30.9	0.867	-0.004	0.041
33.8	0.872	-0.011	0.048
36.6	0.905	-0.020	0.059
39.4	0.927	-0.028	0.062
42.2	0.937	-0.034	0.060
45.0	0.946	-0.040	0.060
47.8	0.949	-0.044	0.056
50.6	0.952	-0.050	0.053
53.4	0.955	-0.055	0.050
56.3	0.957	-0.060	0.045
59.1	0.960	-0.064	0.041
61.9	0.960	-0.068	0.037
64.7	0.958	-0.070	0.032
67.5	0.959	-0.073	0.027
70.3	0.958	-0.074	0.024
73.1	0.960	-0.076	0.019
75.9	0.965	-0.077	0.016
78.8	0.964	-0.079	0.012
81.6	0.962	-0.080	0.007
84.4	0.961	-0.080	0.002
87.2	0.964	-0.080	-0.001
90.0	0.968	-0.080	-0.005

r/R = 0.9

θ	Us	Ut	Ur
92.8	0.969	-0.080	-0.009
95.6	0.970	-0.079	-0.012
98.4	0.971	-0.079	-0.016
101.3	0.972	-0.078	-0.019
104.1	0.975	-0.077	-0.023
106.9	0.977	-0.076	-0.025
109.7	0.979	-0.075	-0.028
112.5	0.980	-0.073	-0.030
115.3	0.981	-0.072	-0.032
118.1	0.981	-0.070	-0.034
120.9	0.982	-0.069	-0.036
123.8	0.983	-0.067	-0.038
126.6	0.984	-0.065	-0.039
129.4	0.985	-0.063	-0.042
132.2	0.984	-0.061	-0.044
135.0	0.985	-0.059	-0.046
137.8	0.984	-0.057	-0.048
140.6	0.984	-0.055	-0.050
143.4	0.984	-0.052	-0.052
146.3	0.984	-0.049	-0.054
149.1	0.984	-0.046	-0.056
151.9	0.984	-0.044	-0.058
154.7	0.983	-0.042	-0.059
157.5	0.983	-0.039	-0.061
160.3	0.983	-0.037	-0.062
163.1	0.983	-0.034	-0.063
165.9	0.983	-0.031	-0.064
168.8	0.982	-0.028	-0.065
171.6	0.982	-0.024	-0.066
174.4	0.982	-0.021	-0.067
177.2	0.982	-0.018	-0.067
180.0	0.982	-0.015	-0.068

Table A2. Model 5653-3 Nominal Wake LDV measurements, inboard shaft (continued)

Model 5653 Nominal Wake LDV Measurements — Inboard Shaft

r/R = 1.0

θ	Us	Ut	Ur
-180.0	0.982	-0.014	-0.067
-177.2	0.982	-0.011	-0.067
-174.4	0.981	-0.008	-0.068
-171.6	0.981	-0.006	-0.068
-168.8	0.981	-0.003	-0.069
-165.9	0.981	-0.001	-0.068
-163.1	0.981	0.003	-0.068
-160.3	0.981	0.006	-0.067
-157.5	0.981	0.010	-0.067
-154.7	0.981	0.013	-0.067
-151.9	0.980	0.016	-0.067
-149.1	0.980	0.018	-0.067
-146.3	0.979	0.021	-0.066
-143.4	0.979	0.024	-0.065
-140.6	0.978	0.026	-0.065
-137.8	0.978	0.030	-0.063
-135.0	0.979	0.033	-0.062
-132.2	0.978	0.036	-0.062
-129.4	0.977	0.039	-0.061
-126.6	0.977	0.042	-0.060
-123.8	0.977	0.045	-0.059
-120.9	0.977	0.048	-0.058
-118.1	0.976	0.052	-0.056
-115.3	0.976	0.055	-0.054
-112.5	0.976	0.059	-0.052
-109.7	0.977	0.062	-0.050
-106.9	0.977	0.065	-0.047
-104.1	0.976	0.069	-0.044
-101.3	0.976	0.072	-0.041
-98.4	0.975	0.075	-0.037
-95.6	0.974	0.077	-0.033
-92.8	0.975	0.080	-0.029
-90.0	0.975	0.082	-0.024

r/R = 1.0

θ	Us	Ut	Ur
-87.2	0.974	0.083	-0.020
-84.4	0.973	0.084	-0.015
-81.6	0.972	0.085	-0.010
-78.8	0.972	0.085	-0.005
-75.9	0.971	0.085	-0.001
-73.1	0.971	0.084	0.004
-70.3	0.970	0.084	0.008
-67.5	0.970	0.082	0.012
-64.7	0.969	0.081	0.017
-61.9	0.967	0.079	0.020
-59.1	0.965	0.076	0.023
-56.3	0.960	0.073	0.027
-53.4	0.952	0.070	0.031
-50.6	0.944	0.066	0.035
-47.8	0.937	0.062	0.039
-45.0	0.930	0.058	0.043
-42.2	0.921	0.055	0.046
-39.4	0.912	0.052	0.048
-36.6	0.904	0.049	0.051
-33.8	0.896	0.047	0.053
-30.9	0.888	0.044	0.056
-28.1	0.883	0.043	0.060
-25.3	0.878	0.041	0.064
-22.5	0.864	0.036	0.063
-19.7	0.847	0.031	0.061
-16.9	0.813	0.023	0.047
-14.1	0.791	0.017	0.035
-11.3	0.771	0.013	0.024
-8.4	0.750	0.011	0.013
-5.6	0.732	0.008	0.005
-2.8	0.714	0.009	0.000
0.0	0.700	0.010	-0.005

r/R = 1.0

θ	Us	Ut	Ur
2.8	0.691	0.013	-0.007
5.6	0.697	0.015	-0.005
8.4	0.698	0.015	-0.003
11.3	0.706	0.014	0.000
14.1	0.730	0.012	0.006
16.9	0.748	0.011	0.013
19.7	0.777	0.011	0.017
22.5	0.803	0.006	0.026
25.3	0.828	0.002	0.035
28.1	0.847	-0.003	0.040
30.9	0.856	-0.006	0.046
33.8	0.863	-0.014	0.057
36.6	0.901	-0.024	0.066
39.4	0.926	-0.031	0.069
42.2	0.928	-0.036	0.064
45.0	0.933	-0.042	0.064
47.8	0.938	-0.047	0.060
50.6	0.943	-0.052	0.057
53.4	0.944	-0.056	0.052
56.3	0.946	-0.060	0.046
59.1	0.947	-0.064	0.043
61.9	0.944	-0.066	0.038
64.7	0.944	-0.069	0.034
67.5	0.940	-0.069	0.029
70.3	0.940	-0.070	0.024
73.1	0.940	-0.070	0.020
75.9	0.944	-0.072	0.016
78.8	0.943	-0.073	0.012
81.6	0.942	-0.073	0.007
84.4	0.944	-0.073	0.003
87.2	0.946	-0.074	0.000
90.0	0.953	-0.075	-0.003

r/R = 1.0

θ	Us	Ut	Ur
92.8	0.955	-0.076	-0.007
95.6	0.961	-0.077	-0.012
98.4	0.962	-0.076	-0.015
101.3	0.963	-0.076	-0.019
104.1	0.966	-0.075	-0.022
106.9	0.971	-0.074	-0.025
109.7	0.976	-0.073	-0.027
112.5	0.977	-0.070	-0.030
115.3	0.978	-0.068	-0.033
118.1	0.980	-0.067	-0.035
120.9	0.981	-0.065	-0.038
123.8	0.982	-0.064	-0.039
126.6	0.982	-0.062	-0.042
129.4	0.982	-0.060	-0.044
132.2	0.982	-0.058	-0.046
135.0	0.981	-0.056	-0.048
137.8	0.983	-0.055	-0.049
140.6	0.984	-0.053	-0.049
143.4	0.985	-0.051	-0.051
146.3	0.984	-0.048	-0.052
149.1	0.984	-0.045	-0.054
151.9	0.984	-0.043	-0.056
154.7	0.983	-0.040	-0.057
157.5	0.983	-0.037	-0.059
160.3	0.983	-0.034	-0.060
163.1	0.983	-0.032	-0.061
165.9	0.983	-0.030	-0.063
168.8	0.982	-0.027	-0.064
171.6	0.982	-0.023	-0.065
174.4	0.982	-0.020	-0.065
177.2	0.982	-0.017	-0.066
180.0	0.982	-0.014	-0.067

Table A3. Average flow, $0.80 \leq r/R \leq 1.05$.

	inboard	outboard
U_x	0.939	0.949
U_y	-0.013	-0.017
U_z	0.031	0.028
yaw	-0.78	-0.96
pitch	1.78	1.60

Table A4. Circumferential mean values of flow, $0.30 \leq r/R \leq 1.05$.

	Inboard			Outboard		
r/R	U_s	U_t	U_r	U_s	U_t	U_r
0.30	0.9663	-0.0029	-0.0652	0.9756	-0.0349	-0.0647
0.35	0.9720	-0.0042	-0.0541	0.9863	-0.0332	-0.0542
0.40	0.9678	-0.0021	-0.0444	0.9811	-0.0289	-0.0447
0.45	0.9668	-0.0014	-0.0373	0.9759	-0.0269	-0.0379
0.50	0.9646	-0.0012	-0.0320	0.9702	-0.0263	-0.0324
0.55	0.9626	-0.0010	-0.0276	0.9660	-0.0257	-0.0277
0.60	0.9598	-0.0008	-0.0240	0.9632	-0.0248	-0.0236
0.65	0.9569	-0.0009	-0.0216	0.9613	-0.0243	-0.0207
0.70	0.9546	-0.0008	-0.0194	0.9598	-0.0232	-0.0184
0.75	0.9514	-0.0005	-0.0175	0.9585	-0.0220	-0.0165
0.80	0.9479	-0.0003	-0.0161	0.9559	-0.0208	-0.0151
0.85	0.9445	-0.0002	-0.0148	0.9529	-0.0195	-0.0138
0.90	0.9404	-0.0001	-0.0136	0.9497	-0.0183	-0.0128
0.95	0.9363	0.0001	-0.0126	0.9463	-0.0172	-0.0120
1.00	0.9321	0.0005	-0.0117	0.9419	-0.0163	-0.0113
1.05	0.9268	0.0010	-0.0111	0.9376	-0.0158	-0.0107

Table A5. Harmonic content of nominal wake, outboard shaft, $r/R = 0.50$.

n	U_s		U_t		U_r	
	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)
0	0.9702	0.0	0.0263	180.0	0.0325	180.0
1	0.0359	144.8	0.1038	46.3	0.0565	299.5
2	0.0317	112.2	0.0108	275.4	0.0219	145.9
3	0.0240	73.2	0.0116	226.7	0.0187	122.9
4	0.0158	26.2	0.0089	201.9	0.0137	100.5
5	0.0115	324.6	0.0061	173.7	0.0087	75.9
6	0.0105	264.9	0.0034	144.6	0.0035	49.1
7	0.0097	216.5	0.0014	118.3	0.0005	311.3
8	0.0077	173.7	0.0003	75.7	0.0020	204.4
9	0.0050	127.0	0.0005	259.1	0.0025	179.9
10	0.0033	57.3	0.0007	223.7	0.0021	160.3
11	0.0037	343.5	0.0006	208.0	0.0014	137.8
12	0.0045	296.4	0.0002	174.2	0.0007	118.3
13	0.0044	259.2	0.0002	340.0	0.0001	109.1
14	0.0033	223.7	0.0004	307.6	0.0002	260.7
15	0.0018	187.5	0.0004	286.8	0.0003	271.1
16	0.0005	132.1	0.0002	266.1	0.0003	264.2

Table A6. Harmonic content of nominal wake, outboard shaft, $r/R = 0.70$.

n	U_s		U_t		U_r	
	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)
0	0.9598	0.0	0.0232	180.0	0.0184	180.0
1	0.0420	156.9	0.0980	51.2	0.0690	308.1
2	0.0353	134.1	0.0018	33.7	0.0174	148.6
3	0.0273	111.2	0.0026	190.3	0.0185	120.3
4	0.0189	87.5	0.0029	186.5	0.0151	98.1
5	0.0113	61.9	0.0028	169.5	0.0106	76.8
6	0.0055	29.2	0.0025	149.3	0.0059	58.1
7	0.0018	325.5	0.0019	128.6	0.0023	37.9
8	0.0017	217.2	0.0013	106.1	0.0004	183.6
9	0.0015	176.8	0.0008	68.2	0.0018	186.3
10	0.0008	141.5	0.0003	41.5	0.0022	170.6
11	0.0005	37.8	0.0003	287.6	0.0020	152.4
12	0.0012	325.4	0.0004	222.6	0.0013	143.3
13	0.0020	299.2	0.0005	216.0	0.0007	143.9
14	0.0021	276.0	0.0005	173.6	0.0004	185.7
15	0.0019	262.1	0.0003	165.6	0.0006	217.1
16	0.0016	251.9	0.0001	112.6	0.0007	220.3

Table A7. Harmonic content of nominal wake, outboard shaft, $r/R = 0.90$.

n	U_s		U_t		U_r	
	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)
0	0.9497	0.0	0.0183	180.0	0.0128	180.0
1	0.0575	160.7	0.0963	51.0	0.0737	310.9
2	0.0468	142.5	0.0040	47.6	0.0130	146.7
3	0.0370	122.3	0.0026	151.2	0.0156	112.6
4	0.0268	99.2	0.0036	150.2	0.0137	90.0
5	0.0182	72.9	0.0031	134.0	0.0101	69.8
6	0.0120	42.1	0.0027	115.6	0.0066	49.3
7	0.0080	9.4	0.0019	94.9	0.0035	24.6
8	0.0057	337.8	0.0013	68.4	0.0012	345.7
9	0.0036	314.0	0.0011	31.2	0.0006	241.6
10	0.0023	298.8	0.0006	330.1	0.0011	197.5
11	0.0012	304.3	0.0005	313.9	0.0011	173.2
12	0.0014	314.5	0.0004	264.5	0.0010	165.0
13	0.0021	307.8	0.0004	260.6	0.0007	156.5
14	0.0022	286.0	0.0003	185.8	0.0003	178.9
15	0.0028	272.9	0.0000	259.9	0.0004	232.5
16	0.0027	250.1	0.0001	325.1	0.0008	239.1

Table A8. Harmonic content of nominal wake, outboard shaft, $r/R = 1.00$.

n	U_s		U_t		U_r	
	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)
0	0.9419	0.0	0.0163	180.0	0.0113	180.0
1	0.0708	160.7	0.0960	50.3	0.0755	311.8
2	0.0563	142.3	0.0048	39.6	0.0111	146.5
3	0.0427	122.0	0.0026	149.5	0.0142	110.1
4	0.0293	98.2	0.0038	149.1	0.0122	86.0
5	0.0183	70.3	0.0034	130.3	0.0093	66.1
6	0.0118	35.2	0.0027	116.7	0.0064	47.2
7	0.0087	359.2	0.0018	96.8	0.0038	23.6
8	0.0067	330.0	0.0011	52.1	0.0018	355.1
9	0.0051	311.9	0.0008	5.8	0.0006	286.8
10	0.0036	298.5	0.0007	330.4	0.0011	235.6
11	0.0027	285.5	0.0008	318.9	0.0013	199.7
12	0.0023	284.7	0.0005	273.6	0.0013	182.8
13	0.0027	270.7	0.0006	290.3	0.0009	193.0
14	0.0028	258.9	0.0004	243.6	0.0008	191.8
15	0.0031	254.0	0.0004	256.2	0.0009	230.2
16	0.0029	234.8	0.0001	227.3	0.0011	232.6

Table A9. Harmonic content of nominal wake, inboard shaft, $r/R = 0.50$.

n	U_s		U_t		U_r	
	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)
0	0.9646	0.0	0.0012	180.0	0.0320	180.0
1	0.0429	175.4	0.0850	76.4	0.0386	351.3
2	0.0364	159.3	0.0051	295.6	0.0139	153.1
3	0.0263	144.1	0.0090	264.0	0.0134	162.1
4	0.0172	127.4	0.0066	258.6	0.0100	158.0
5	0.0096	105.8	0.0044	251.2	0.0067	153.4
6	0.0044	65.7	0.0027	239.9	0.0041	157.2
7	0.0033	339.7	0.0013	231.9	0.0026	169.6
8	0.0051	299.2	0.0006	248.0	0.0016	187.2
9	0.0060	276.5	0.0002	336.4	0.0011	213.0
10	0.0052	259.6	0.0006	346.1	0.0008	243.0
11	0.0035	243.2	0.0007	350.5	0.0006	265.6
12	0.0019	222.3	0.0007	348.1	0.0005	301.8
13	0.0009	165.8	0.0005	343.9	0.0005	335.4
14	0.0012	92.4	0.0003	345.2	0.0006	349.6
15	0.0017	61.7	0.0001	318.8	0.0006	354.5
16	0.0016	39.6	0.0001	133.5	0.0005	353.4

Table A10. Harmonic content of nominal wake, inboard shaft, $r/R = 0.70$.

n	U_s		U_t		U_r	
	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)
0	0.9546	0.0	0.0008	180.0	0.0194	180.0
1	0.0503	179.4	0.0777	77.5	0.0503	350.0
2	0.0378	171.3	0.0018	273.7	0.0108	154.0
3	0.0255	165.5	0.0077	259.0	0.0147	163.6
4	0.0168	159.3	0.0051	250.8	0.0112	159.4
5	0.0100	151.9	0.0031	237.0	0.0076	150.2
6	0.0050	146.0	0.0017	217.4	0.0046	148.3
7	0.0019	158.7	0.0009	221.0	0.0027	162.7
8	0.0019	218.1	0.0003	233.5	0.0017	189.0
9	0.0021	239.6	0.0002	58.2	0.0013	212.9
10	0.0021	237.7	0.0005	1.9	0.0014	248.4
11	0.0016	240.7	0.0007	7.2	0.0015	255.8
12	0.0005	210.3	0.0009	340.8	0.0012	258.1
13	0.0006	84.2	0.0007	340.6	0.0006	274.5
14	0.0011	61.0	0.0004	330.9	0.0005	317.2
15	0.0016	50.3	0.0003	295.1	0.0005	351.7
16	0.0016	39.0	0.0001	189.0	0.0005	0.0

Table A11. Harmonic content of nominal wake, inboard shaft, $r/R = 0.90$.

n	U_s		U_t		U_r	
	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)
0	0.9404	0.0	0.0001	180.0	0.0136	180.0
1	0.0708	176.7	0.0758	77.6	0.0560	350.3
2	0.0491	171.7	0.0008	54.9	0.0076	151.4
3	0.0338	173.4	0.0082	266.9	0.0153	167.2
4	0.0233	167.4	0.0058	266.3	0.0122	161.6
5	0.0141	152.0	0.0030	236.9	0.0079	143.7
6	0.0074	137.3	0.0023	216.6	0.0054	140.1
7	0.0044	129.4	0.0015	211.4	0.0034	145.9
8	0.0028	144.1	0.0009	201.4	0.0013	146.4
9	0.0020	178.3	0.0006	211.5	0.0008	221.7
10	0.0020	208.6	0.0004	284.8	0.0012	238.6
11	0.0016	219.7	0.0004	285.9	0.0013	254.0
12	0.0008	219.7	0.0007	334.3	0.0011	251.3
13	0.0003	21.8	0.0004	331.5	0.0008	258.3
14	0.0010	31.9	0.0005	347.8	0.0004	281.7
15	0.0011	40.7	0.0004	350.8	0.0003	342.8
16	0.0009	41.3	0.0002	352.5	0.0005	4.9

Table A12. Harmonic content of nominal wake, inboard shaft, $r/R = 1.00$.

n	U_s		U_t		U_r	
	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)	Amplitude ($/U_\infty$)	Phase (deg.)
0	0.9321	0.0	0.0005	0.0	0.0117	180.0
1	0.0821	174.4	0.0740	77.7	0.0578	350.7
2	0.0529	171.1	0.0017	105.3	0.0062	148.8
3	0.0368	177.5	0.0078	268.5	0.0157	167.3
4	0.0273	171.1	0.0055	280.0	0.0124	161.1
5	0.0180	151.1	0.0025	250.9	0.0082	145.1
6	0.0107	132.8	0.0027	221.5	0.0067	139.4
7	0.0062	128.8	0.0022	205.2	0.0039	138.7
8	0.0043	145.7	0.0012	189.4	0.0017	151.6
9	0.0029	164.1	0.0009	232.7	0.0009	193.2
10	0.0019	193.1	0.0009	247.9	0.0011	236.6
11	0.0010	208.7	0.0006	261.9	0.0013	242.2
12	0.0002	258.9	0.0006	324.3	0.0012	246.4
13	0.0003	15.1	0.0004	308.2	0.0012	249.4
14	0.0009	50.5	0.0006	325.2	0.0005	252.7
15	0.0011	29.5	0.0003	296.2	0.0003	309.8
16	0.0012	5.7	0.0004	319.4	0.0005	5.4

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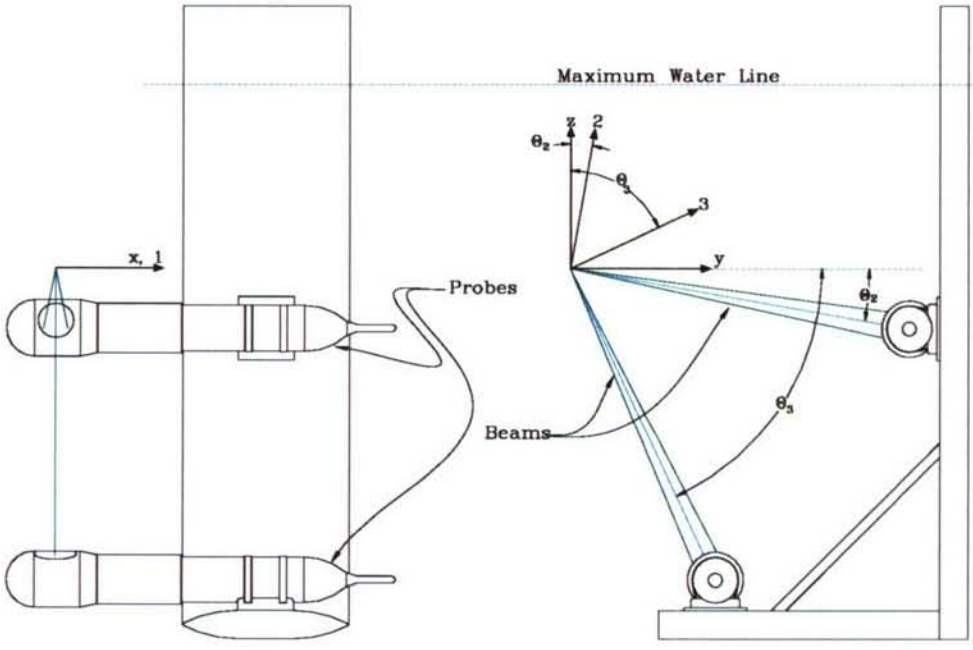


Figure A1. Fiber-optic probes and strut.

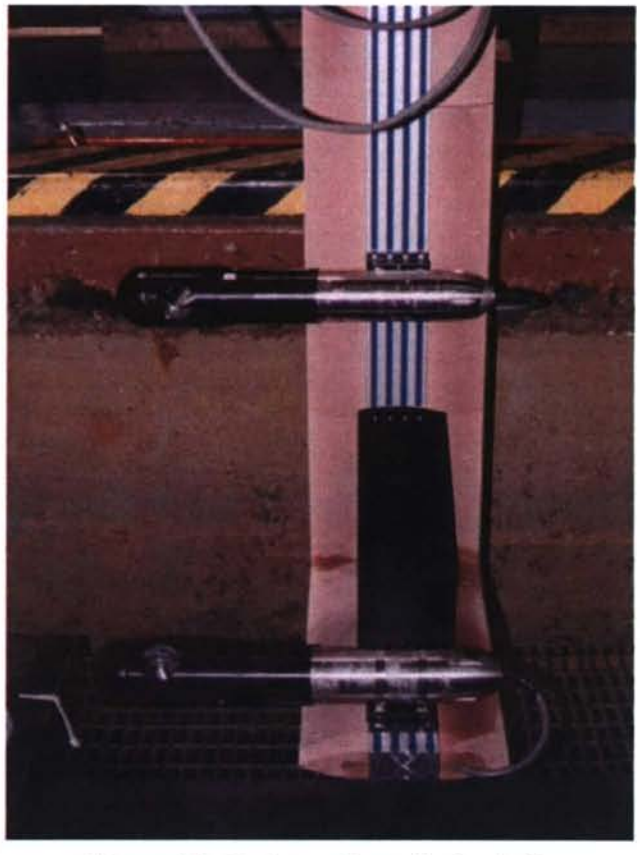
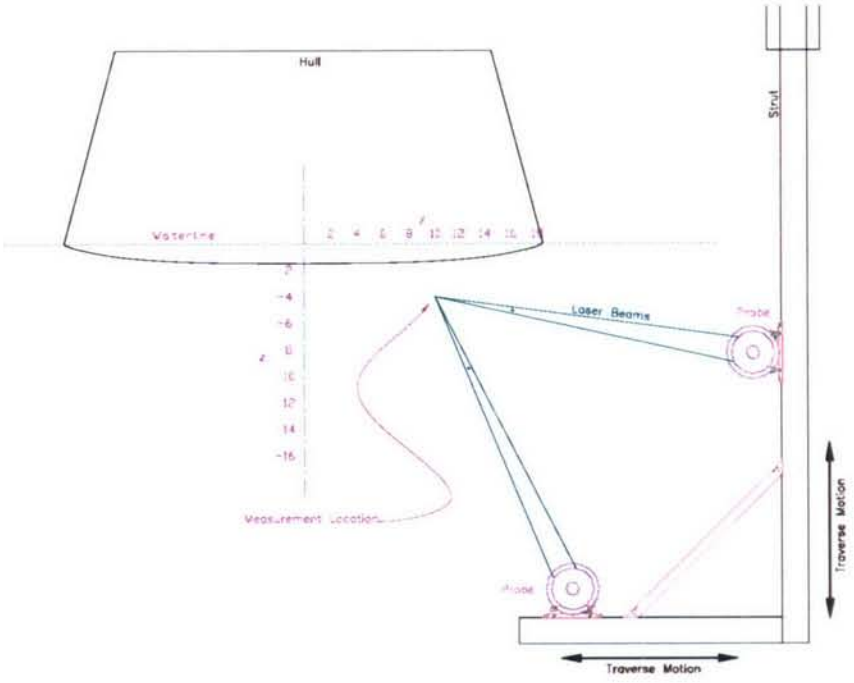


Figure A2. Probes and strut in dry dock.



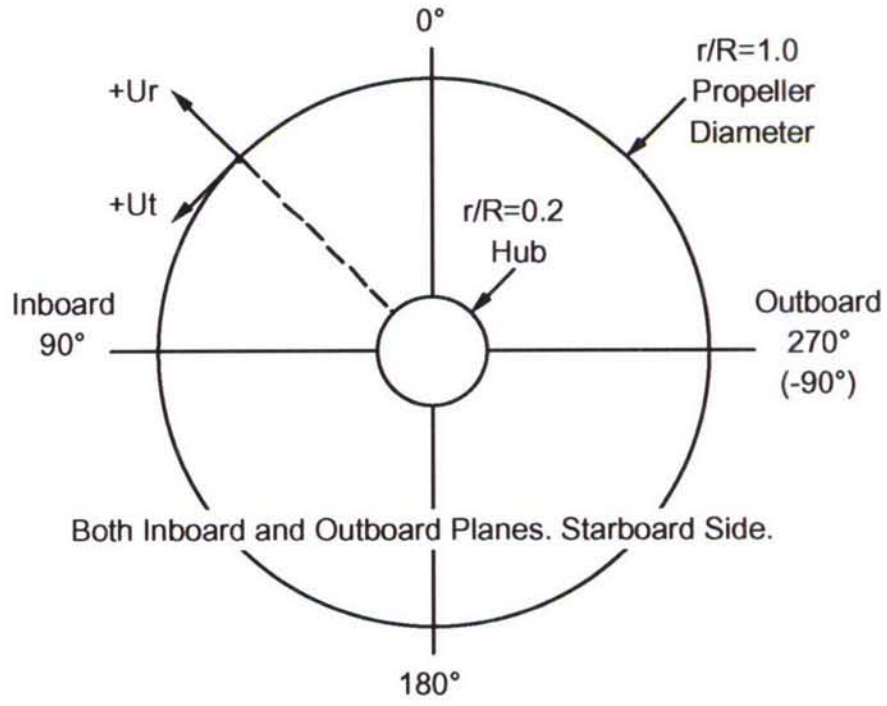


Fig A3. Probes, strut, hull, and coordinate system

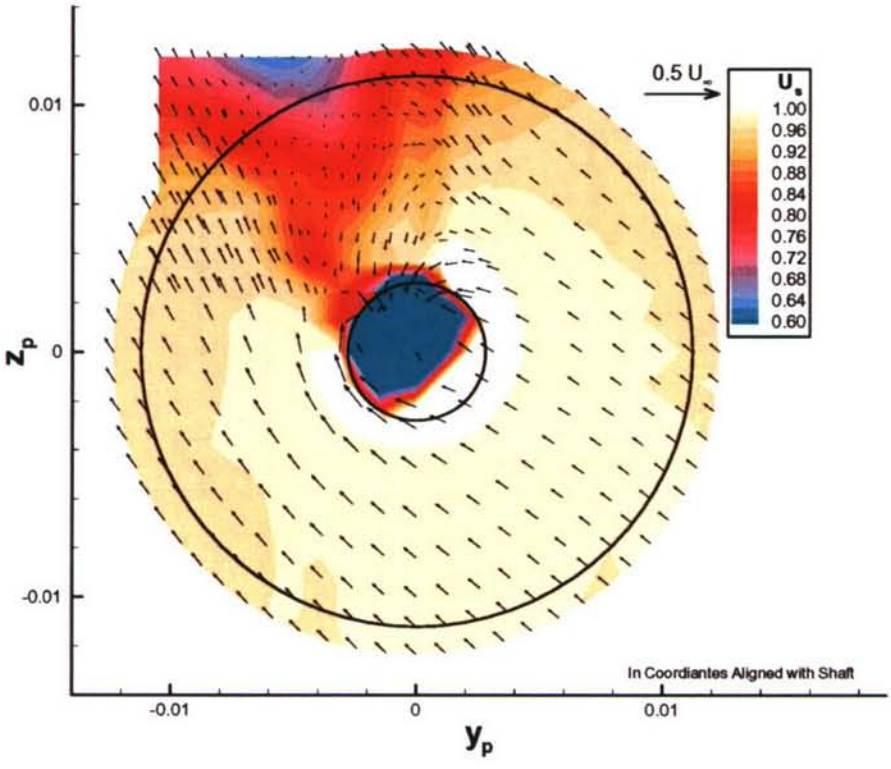


Fig A4. Measured velocities, outboard shaft.

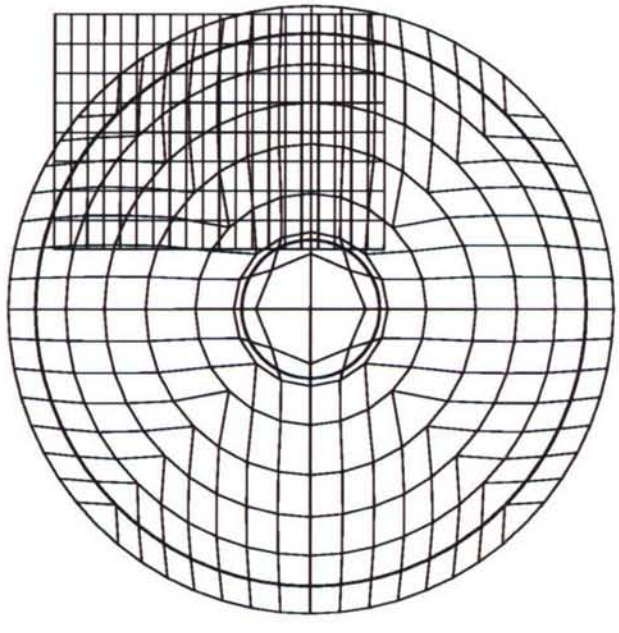


Fig A5. Measurement grid, outboard shaft.

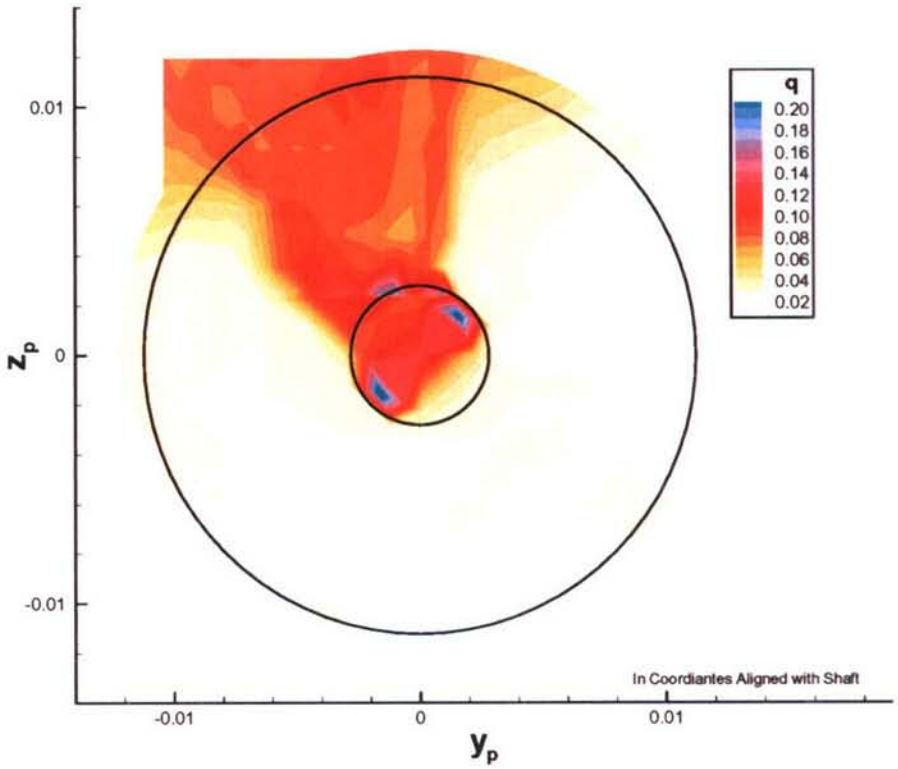


Fig A6. Measured rms velocities, outboard shaft.

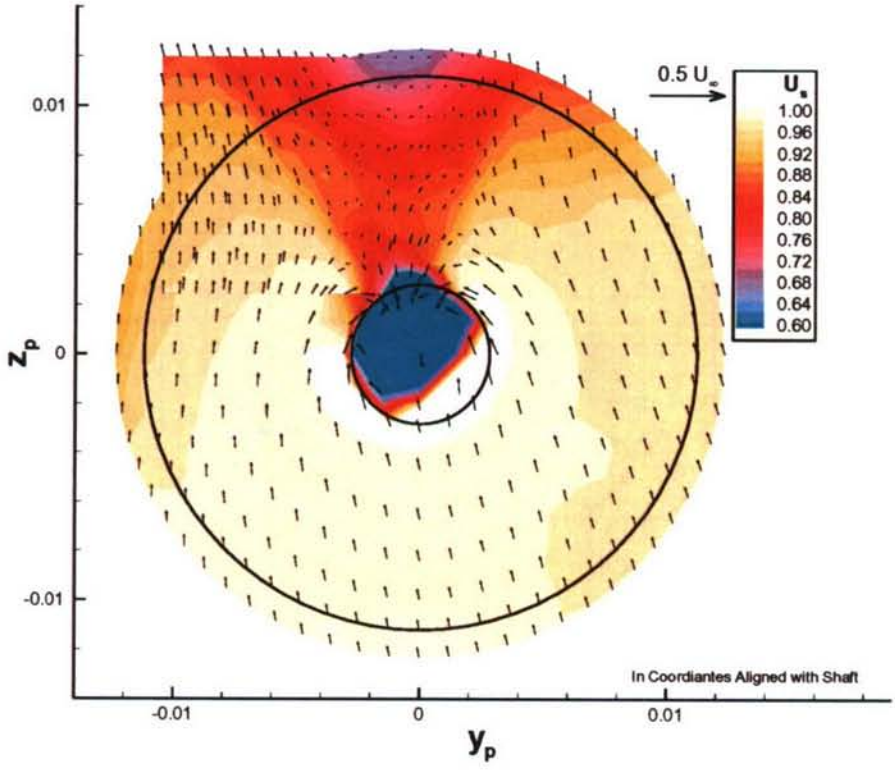


Fig A7. Measured velocities, inboard shaft.

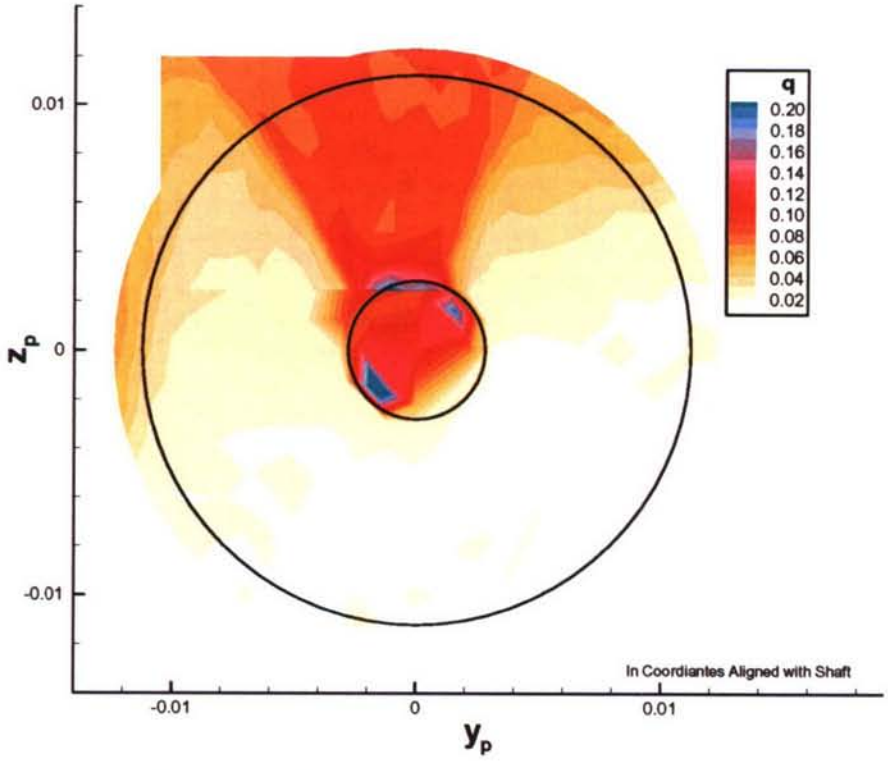


Fig A8. Measured rms velocities, inboard shaft.

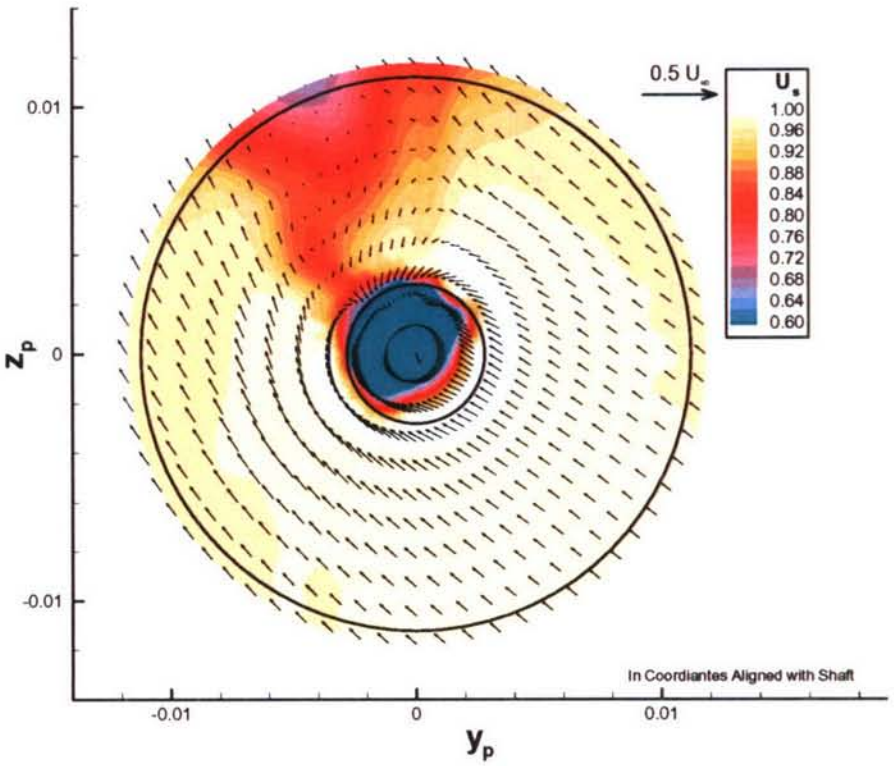


Fig A9. Velocities interpolated onto circular grid for harmonic analysis, outboard shaft. Only every other vector shown for clarity.

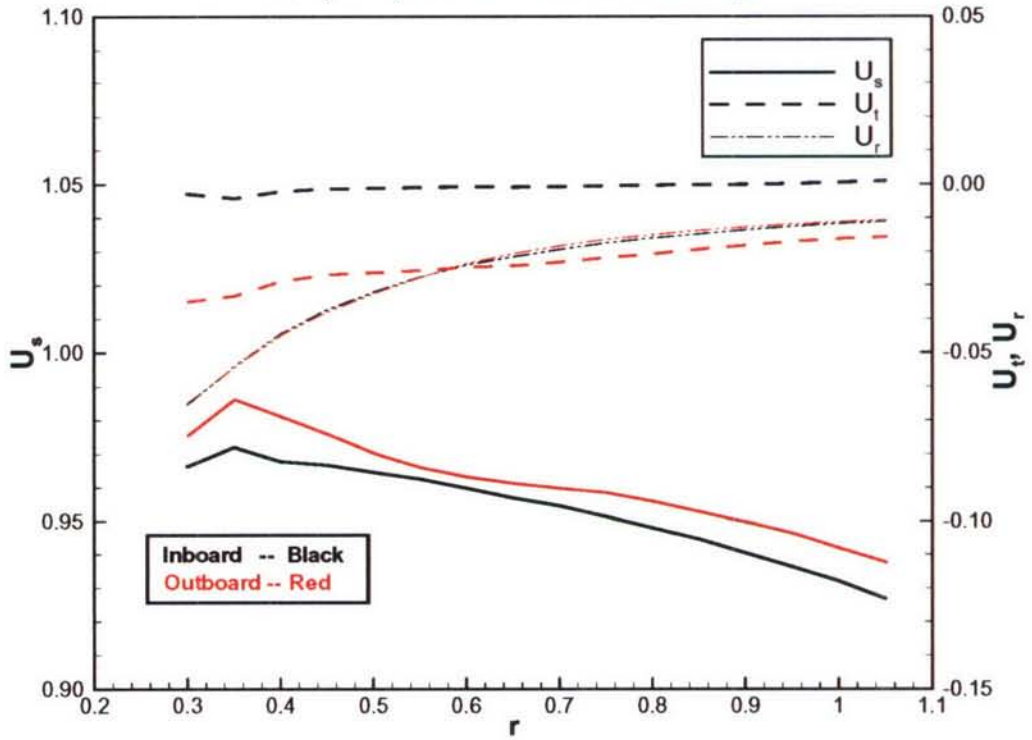


Fig A10. Circumferential mean velocities, inboard and outboard shafts, $0.30 \leq r/R \leq 1.05$.

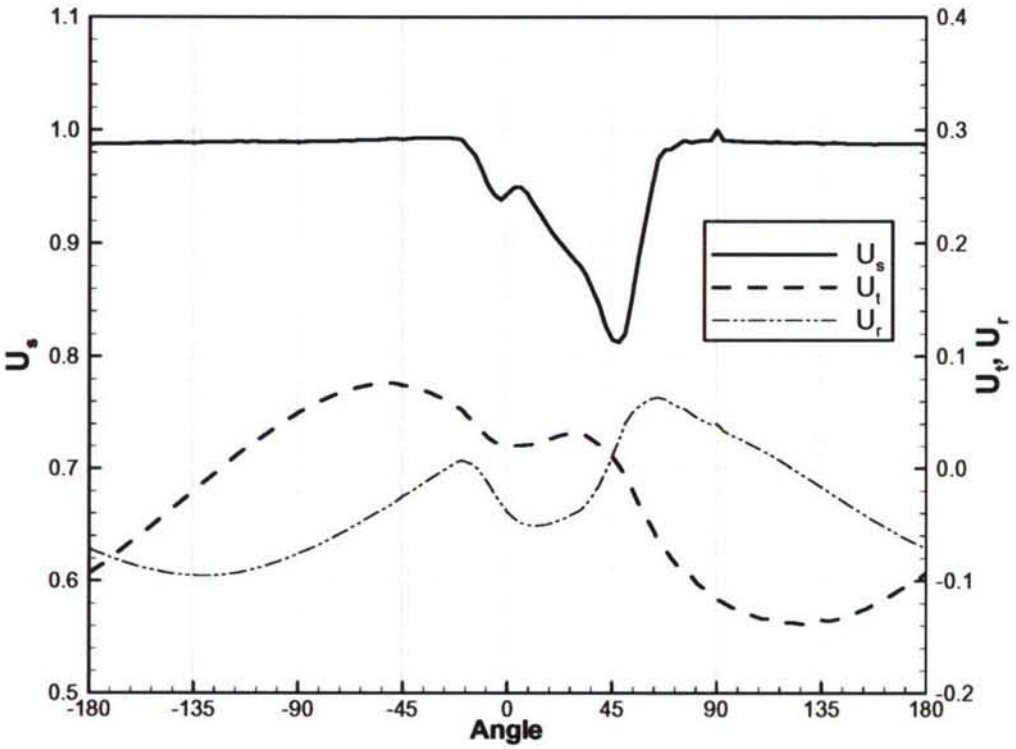


Fig A11. Velocities at outboard shaft, $r/R = 0.50$.

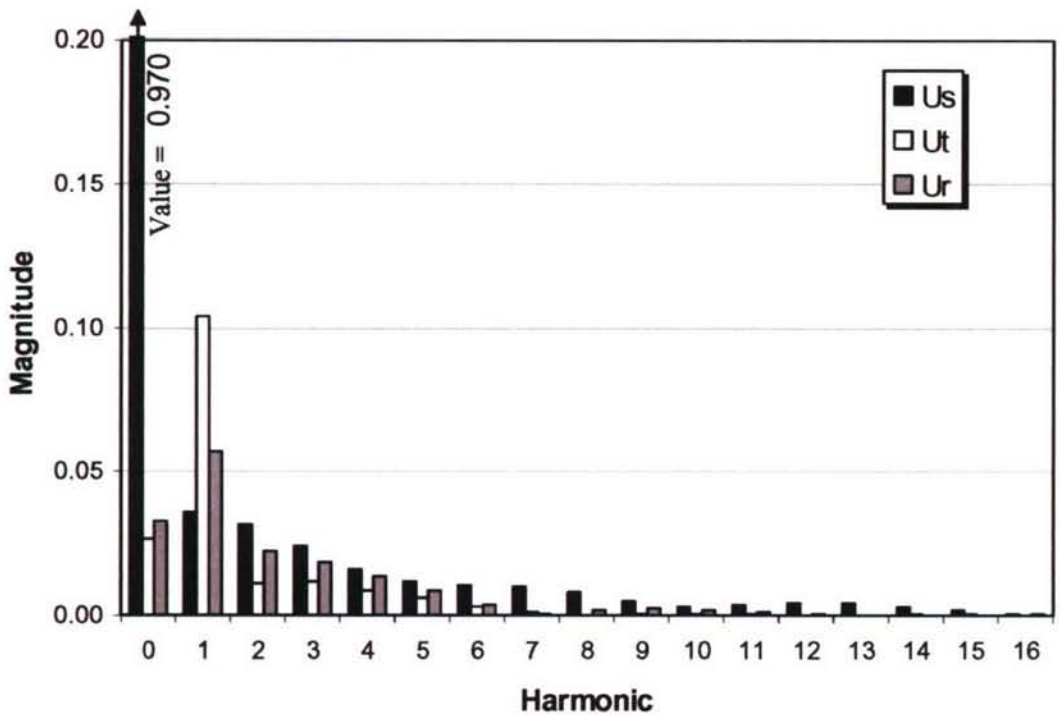


Fig A12. Harmonic content of nominal wake, outboard shaft, $r/R = 0.50$.

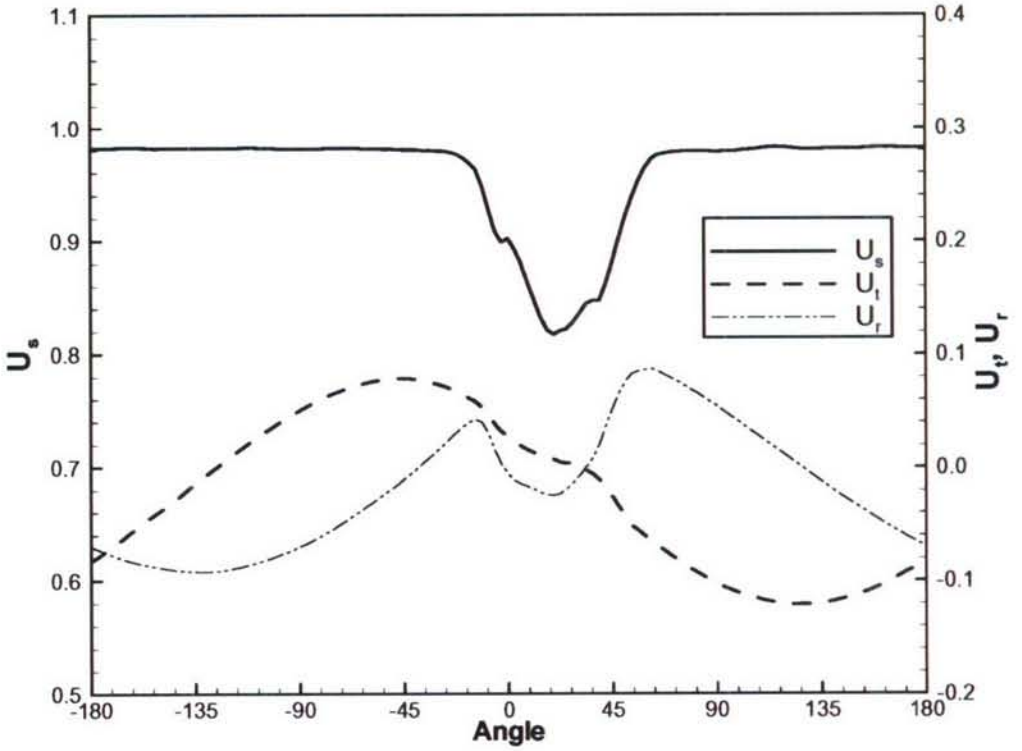


Fig A13. Velocities at outboard shaft, $r/R = 0.70$.

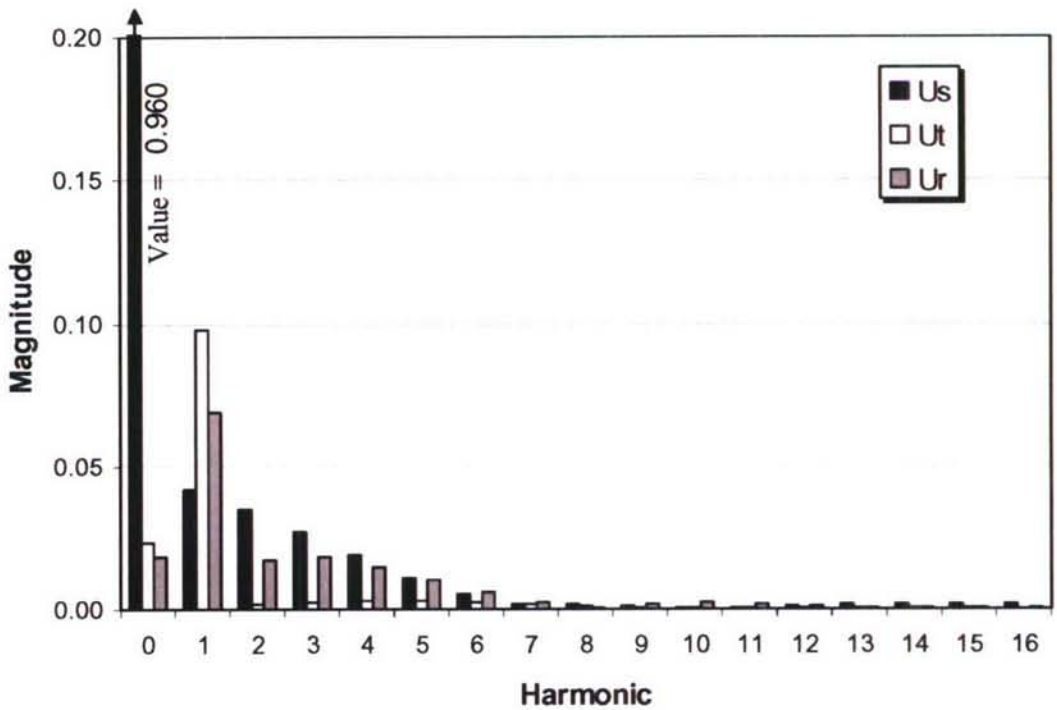


Fig A14. Harmonic content of nominal wake, outboard shaft, $r/R = 0.70$.

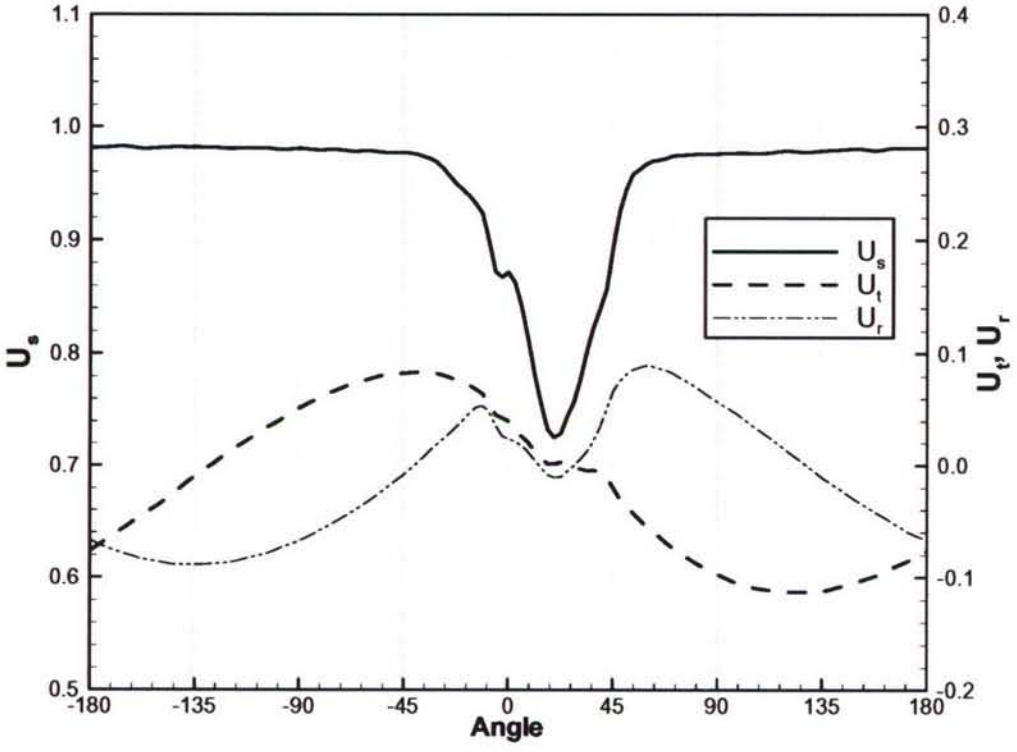


Fig A15. Velocities at outboard shaft, $r/R = 0.90$.

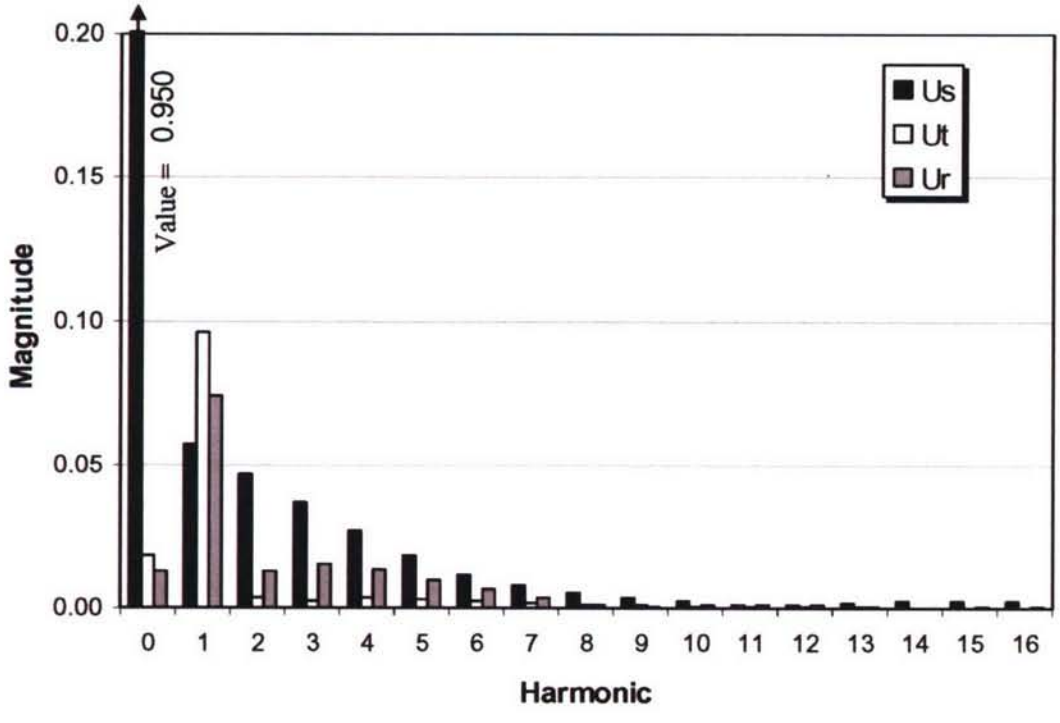


Fig A16. Harmonic content of nominal wake, outboard shaft, $r/R = 0.90$.

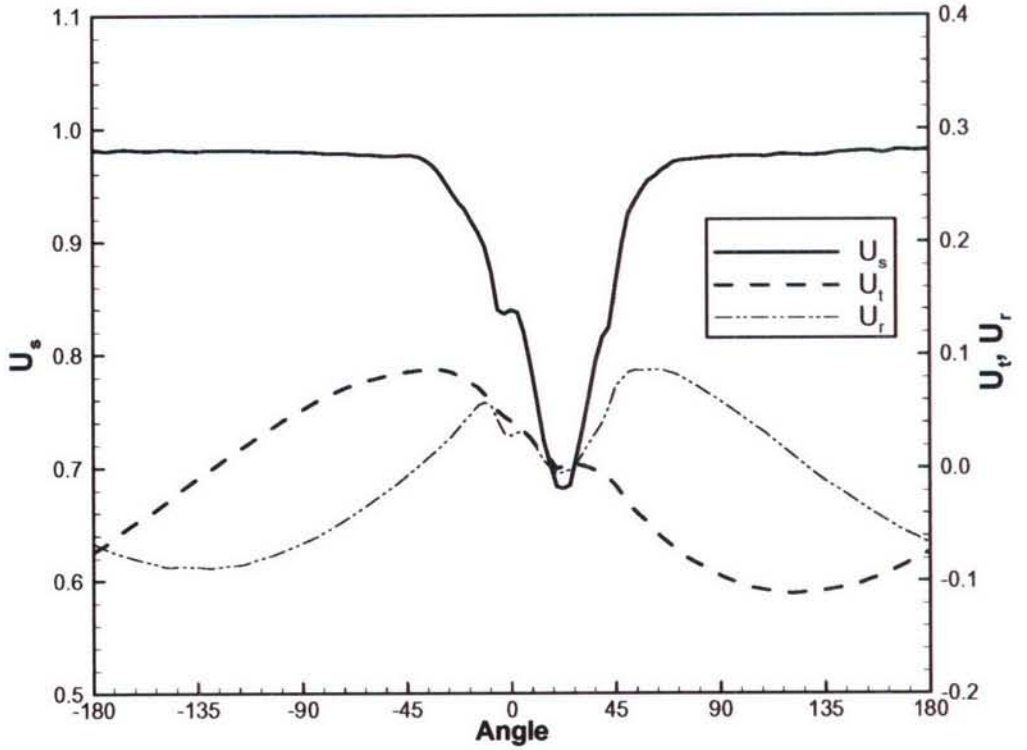


Fig A17. Velocities at outboard shaft, $r/R = 1.00$.

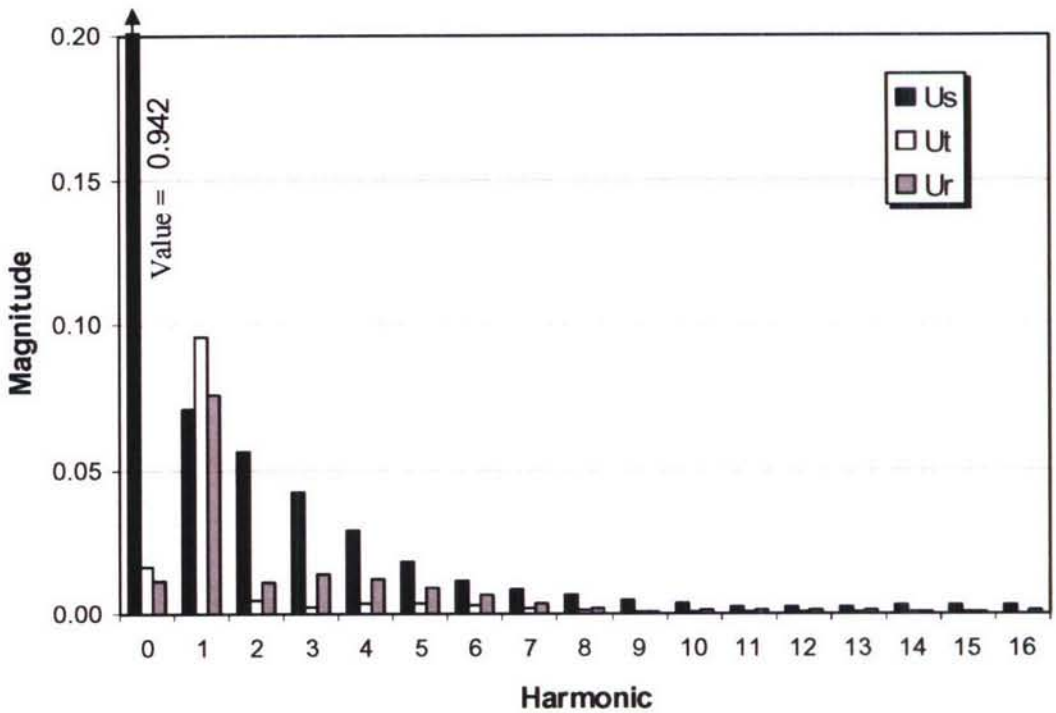


Fig A18. Harmonic content of nominal wake, outboard shaft, $r/R = 1.00$.

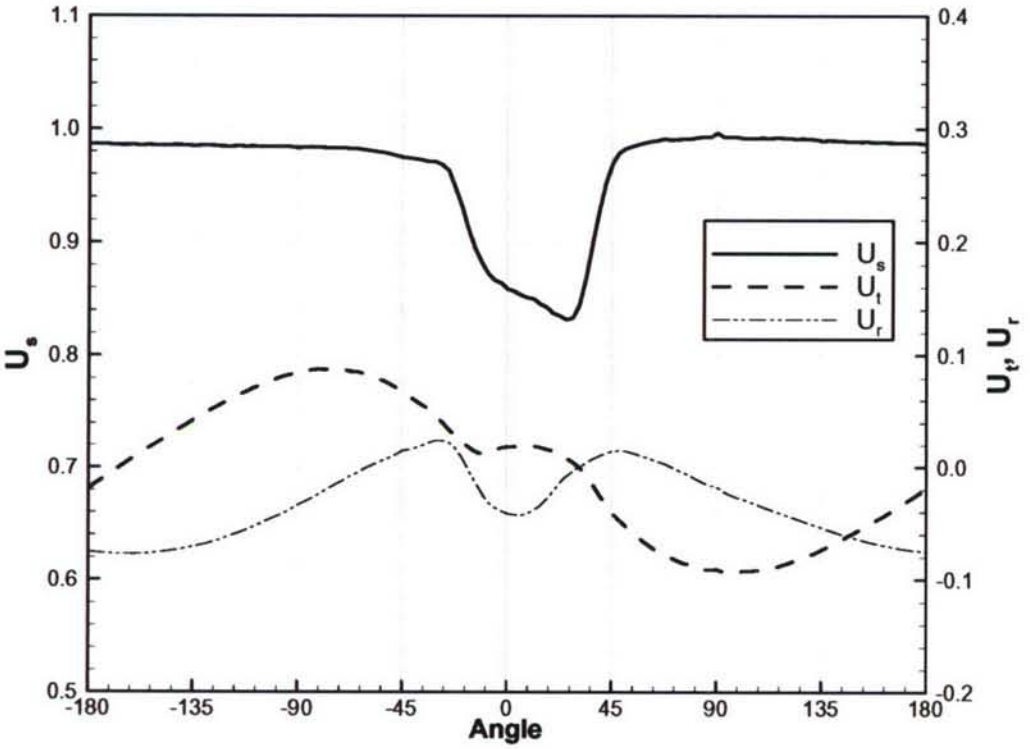


Fig A19. Velocities at inboard shaft, $r/R = 0.50$.

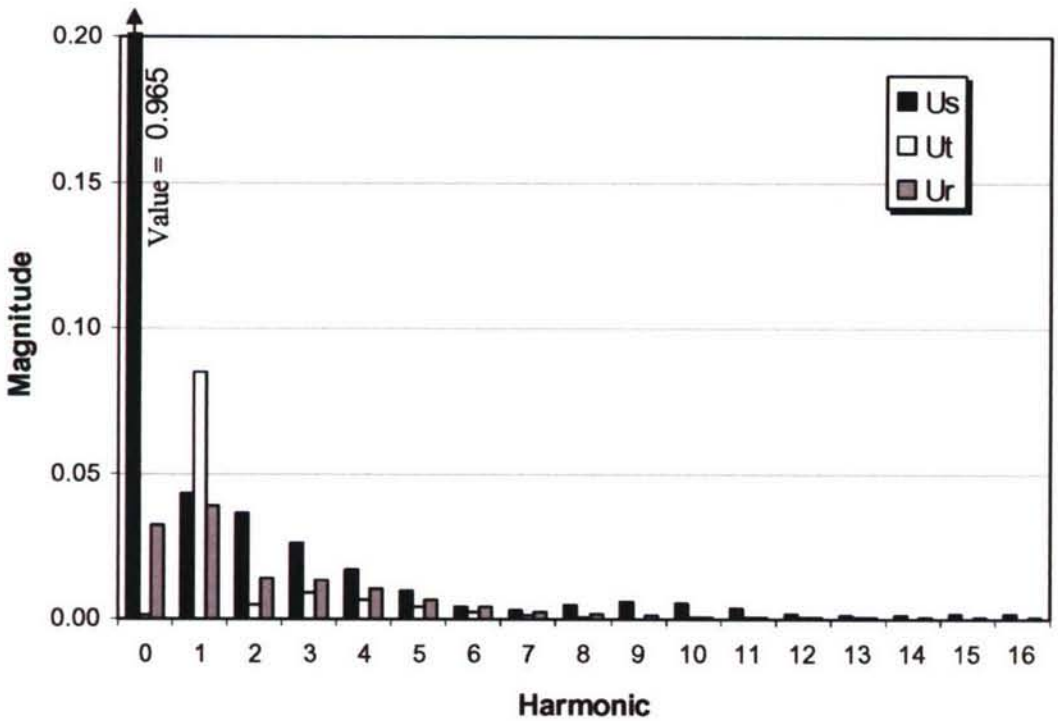


Fig A20. Harmonic content of nominal wake, inboard shaft, $r/R = 0.50$.

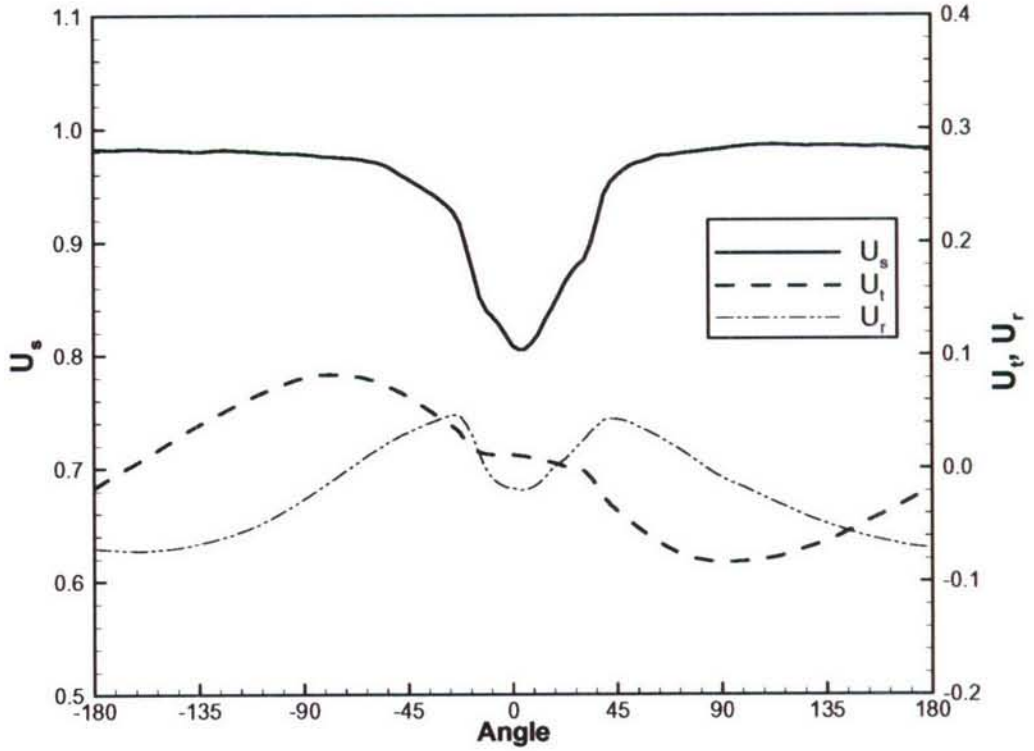


Fig A21. Velocities at inboard shaft, $r/R = 0.70$.

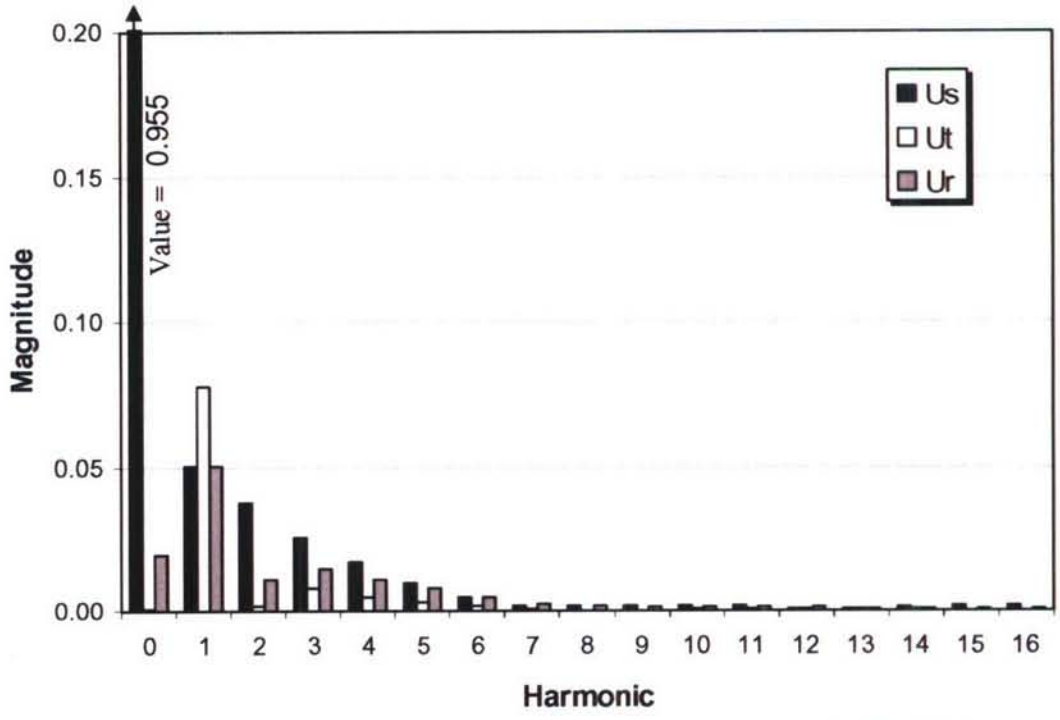


Fig A22. Harmonic content of nominal wake, inboard shaft, $r/R = 0.70$.

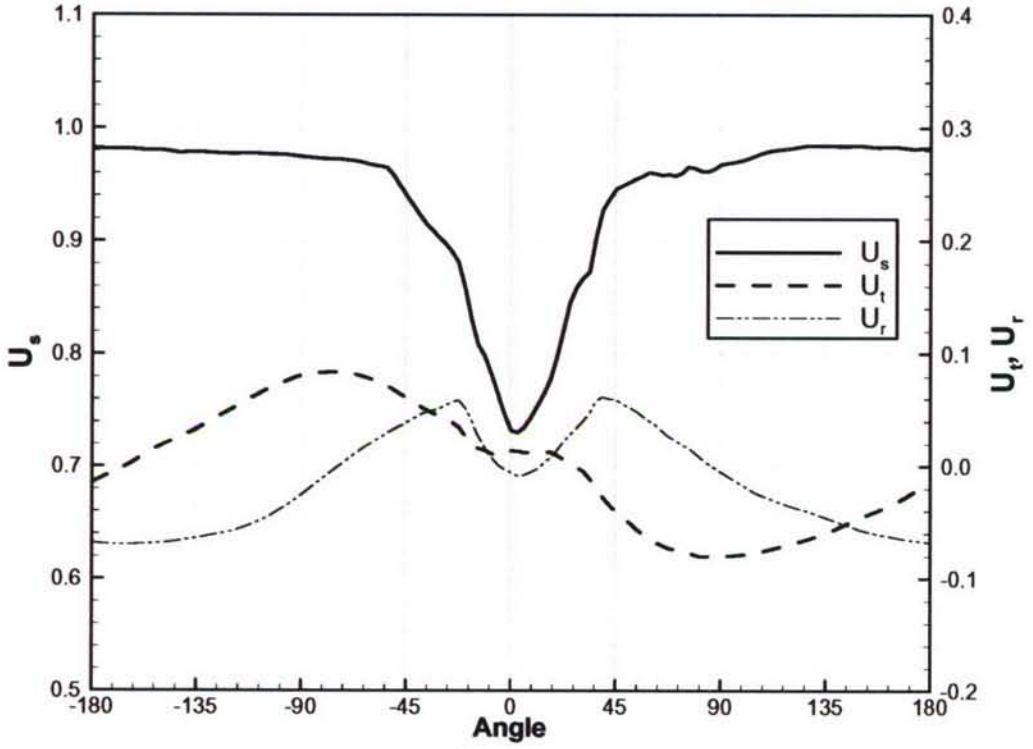


Fig A23. Velocities at inboard shaft, $r/R = 0.90$.

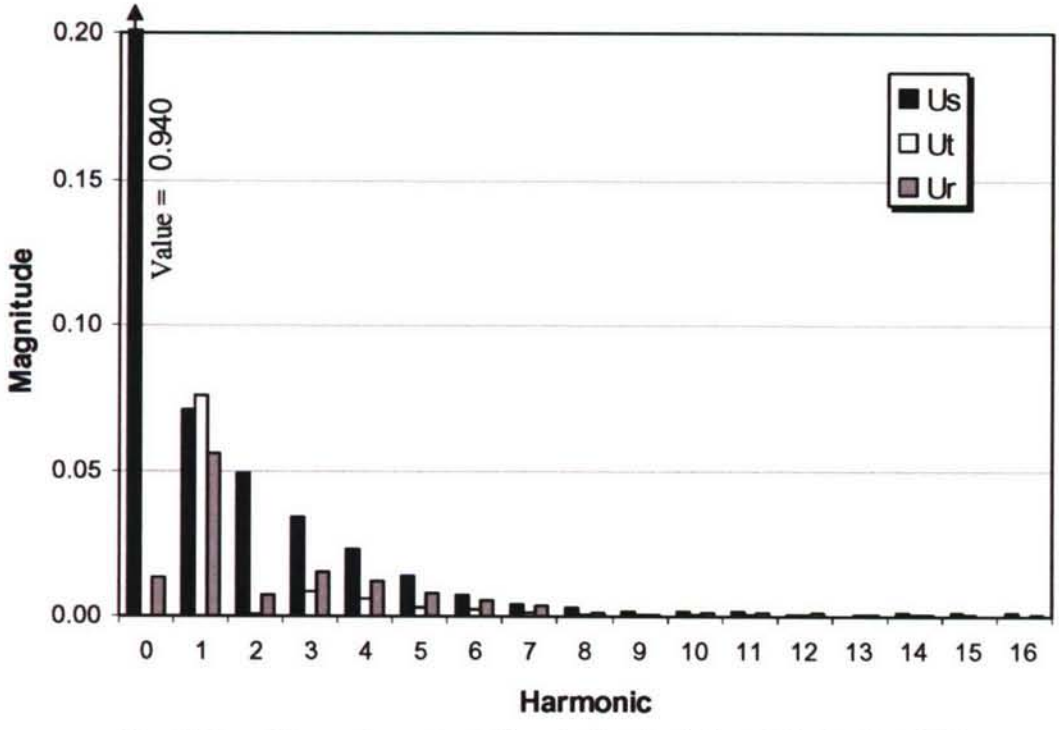


Fig A24. Harmonic content of nominal wake, inboard shaft, $r/R = 0.90$.

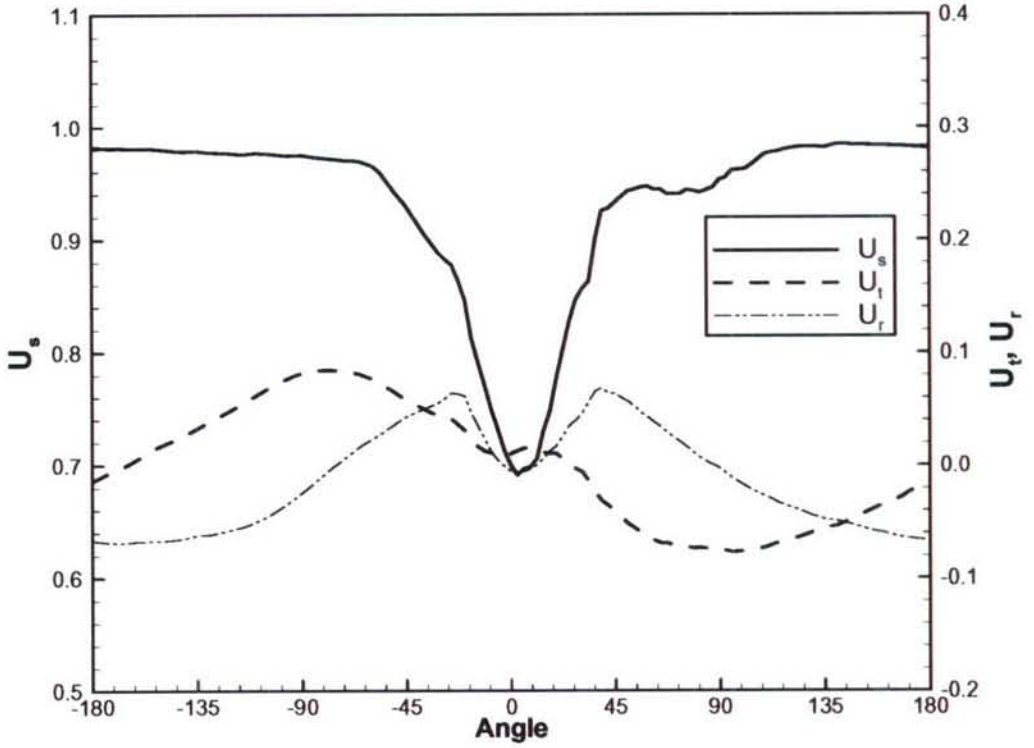


Fig A25. Velocities at inboard shaft, $r/R = 1.00$.

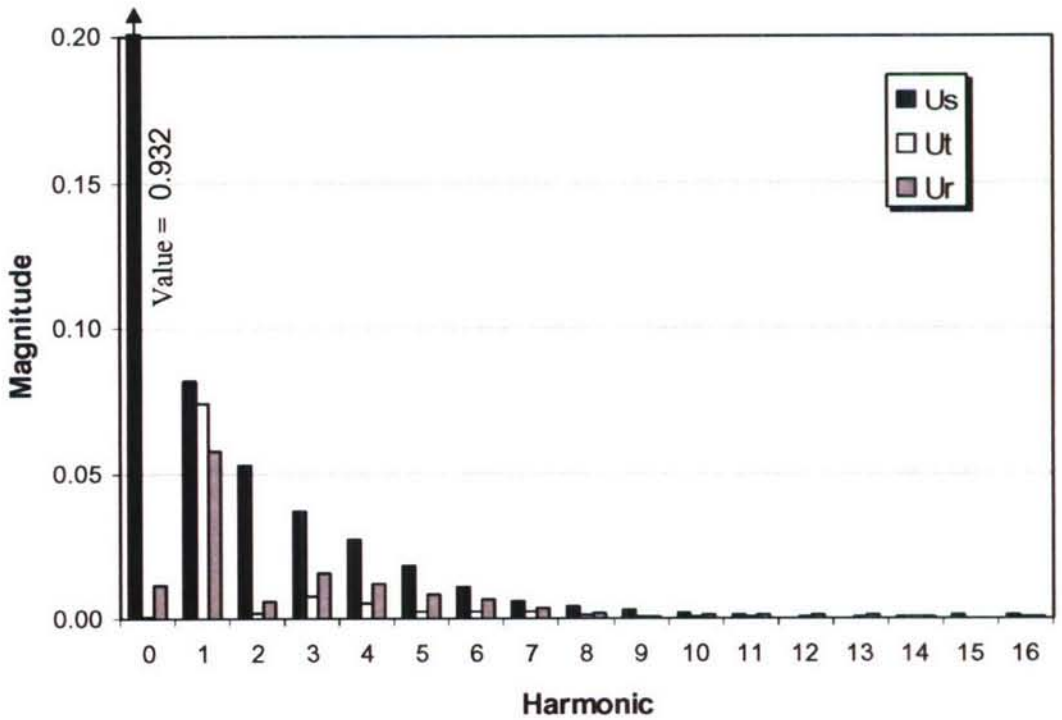


Fig A26. Harmonic content of nominal wake, inboard shaft, $r/R = 1.00$.

APPENDIX B

SERIES 3: STOCK PROPELLER POWERING

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FIGURES OF APPENDIX B

TABLES OF APPENDIX B

TABLES OF APPENDIX B (continued) Page

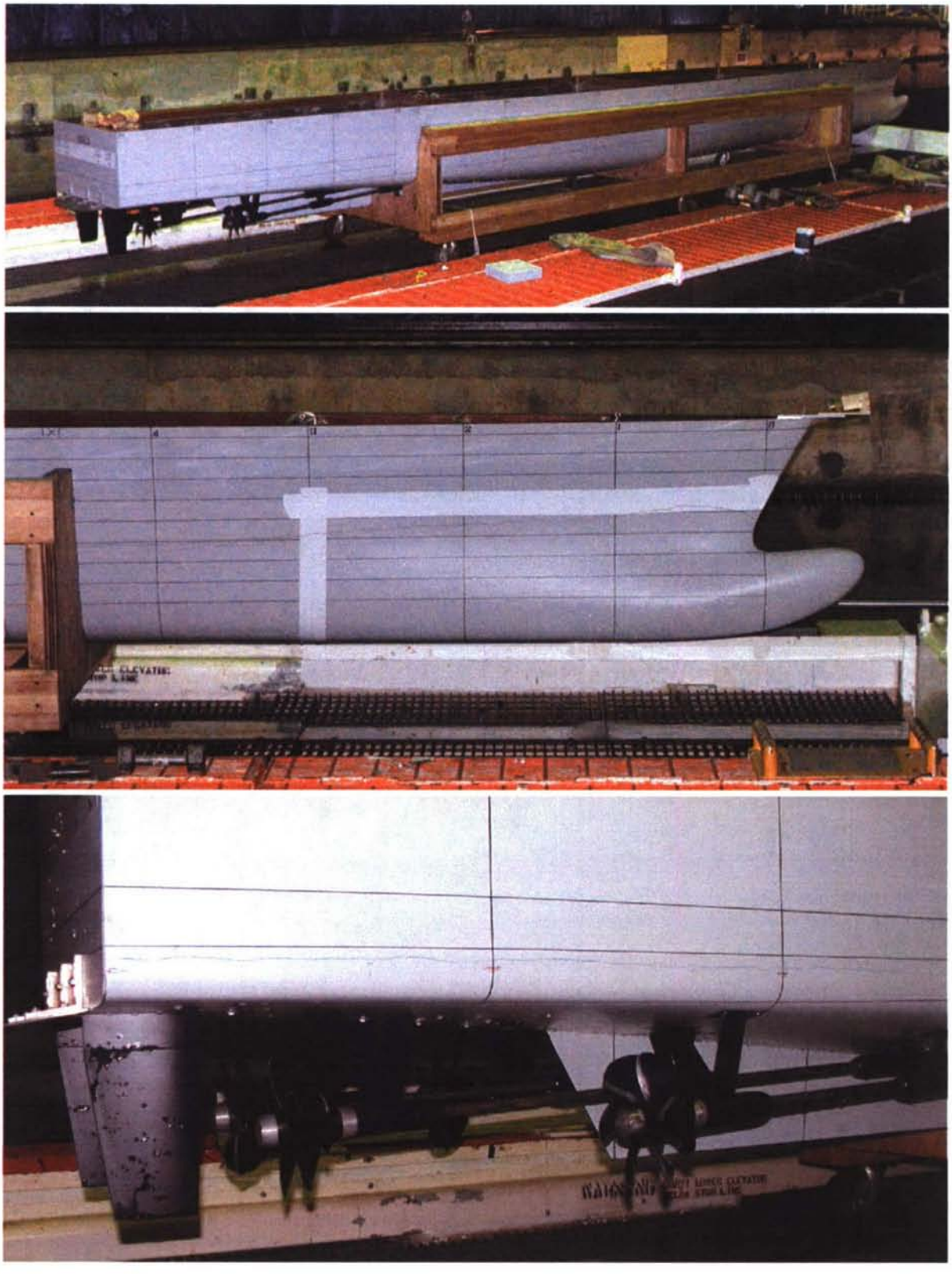


Fig B1. JHSS Model 5653-3, stock propeller series 5233-5, in Carriage 1 dry dock

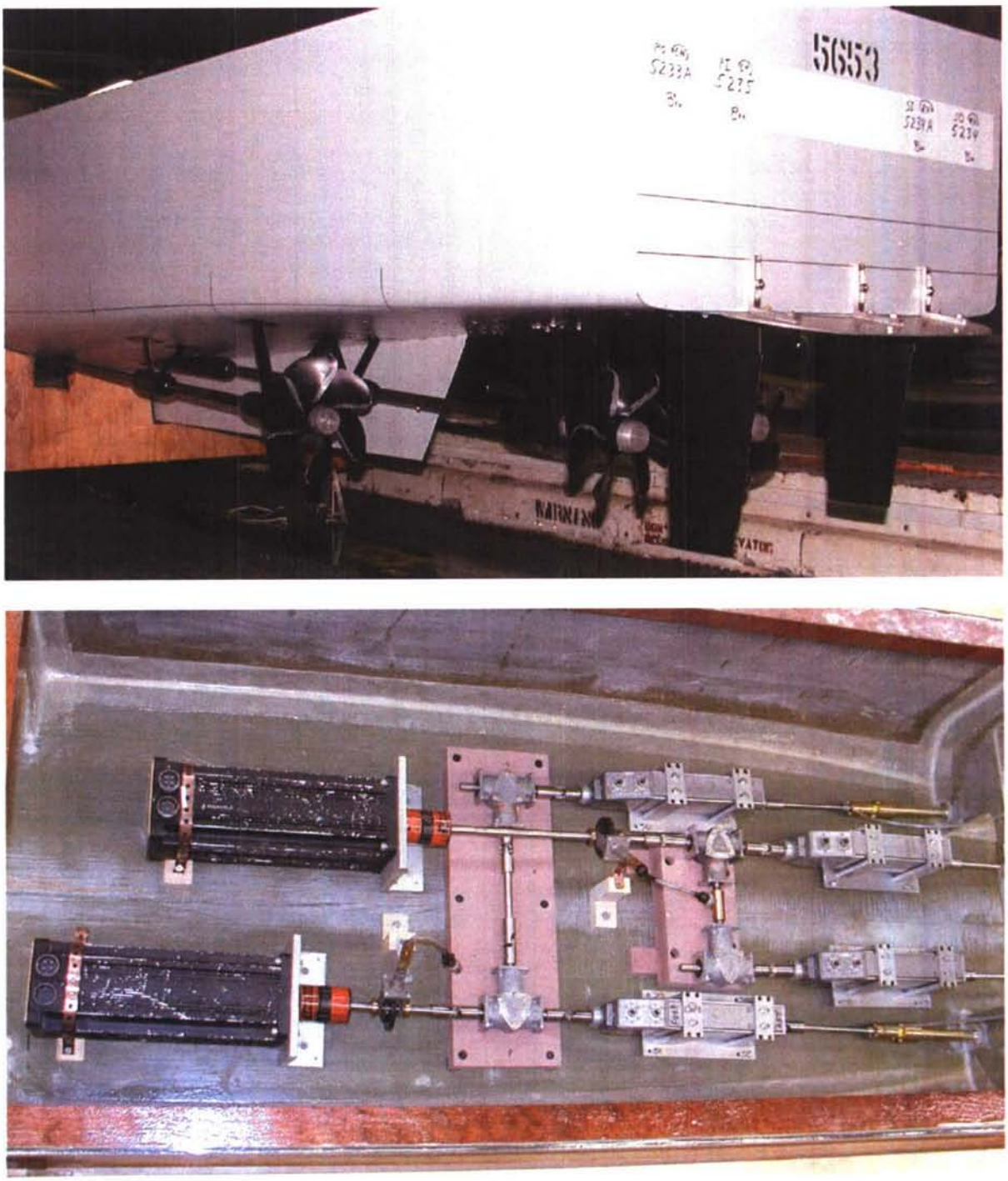
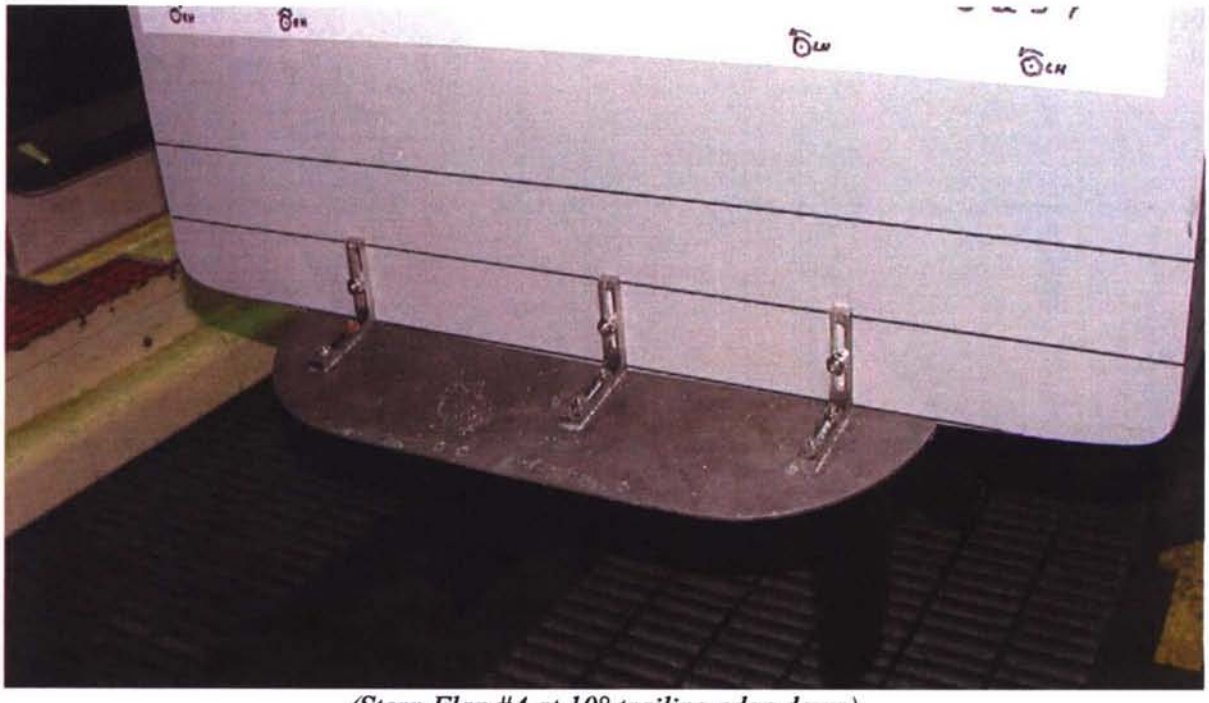


Fig B1. JHSS Model 5653-3, stock propeller series 5233-5, in Carriage 1 dry dock (continued)



(Stern Flap #4 at 10° trailing edge down)

Fig B1. JHSS Model 5653-3, stock propeller series 5233-5, in Carriage 1 dry dock (continued)

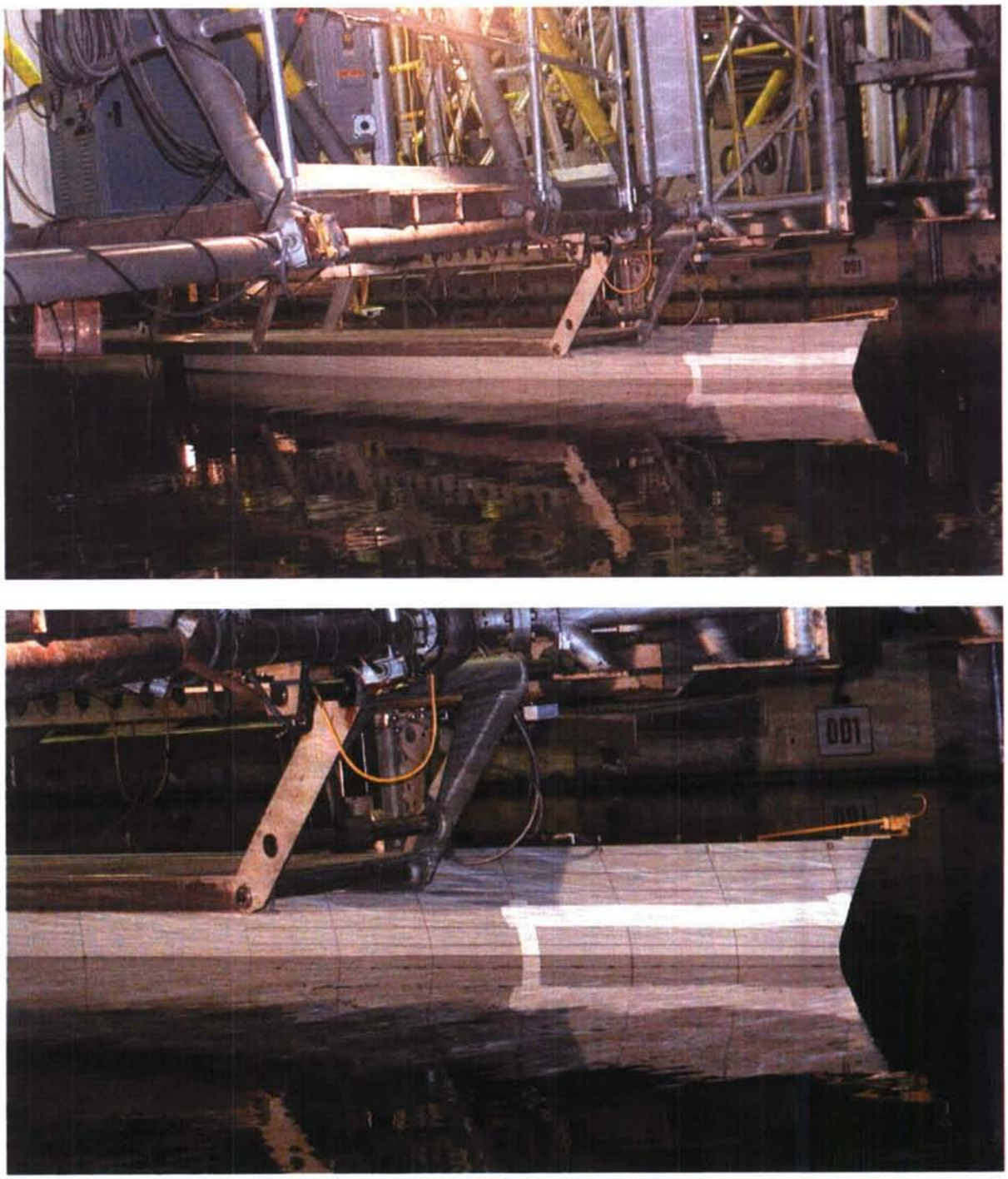


Fig B2. JHSS Model 5653-3 installed under Carriage 1 for Series 3 tests

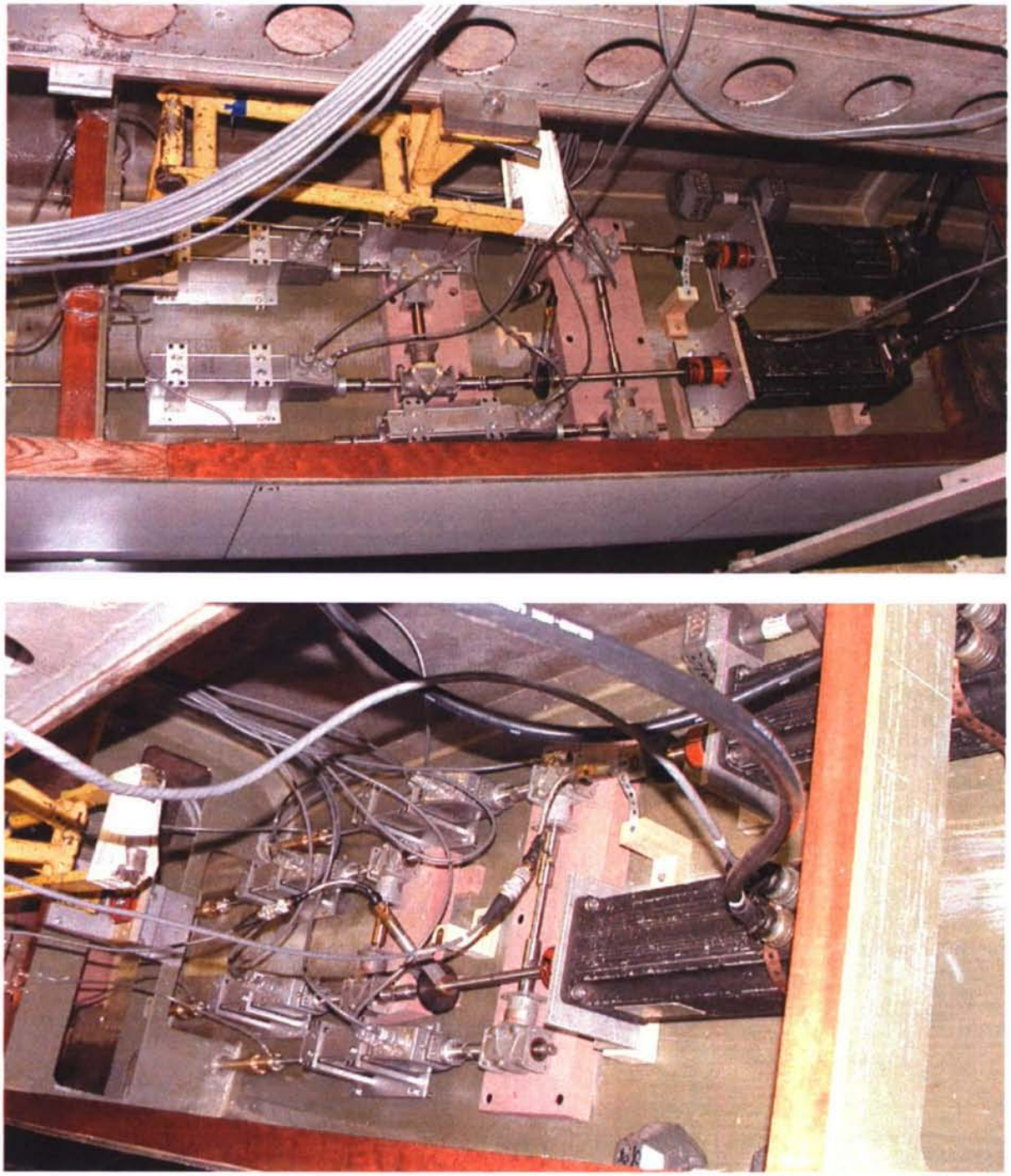


Fig B2. JHSS Model 5653-3 installed under Carriage 1 for Series 3 tests (continued)

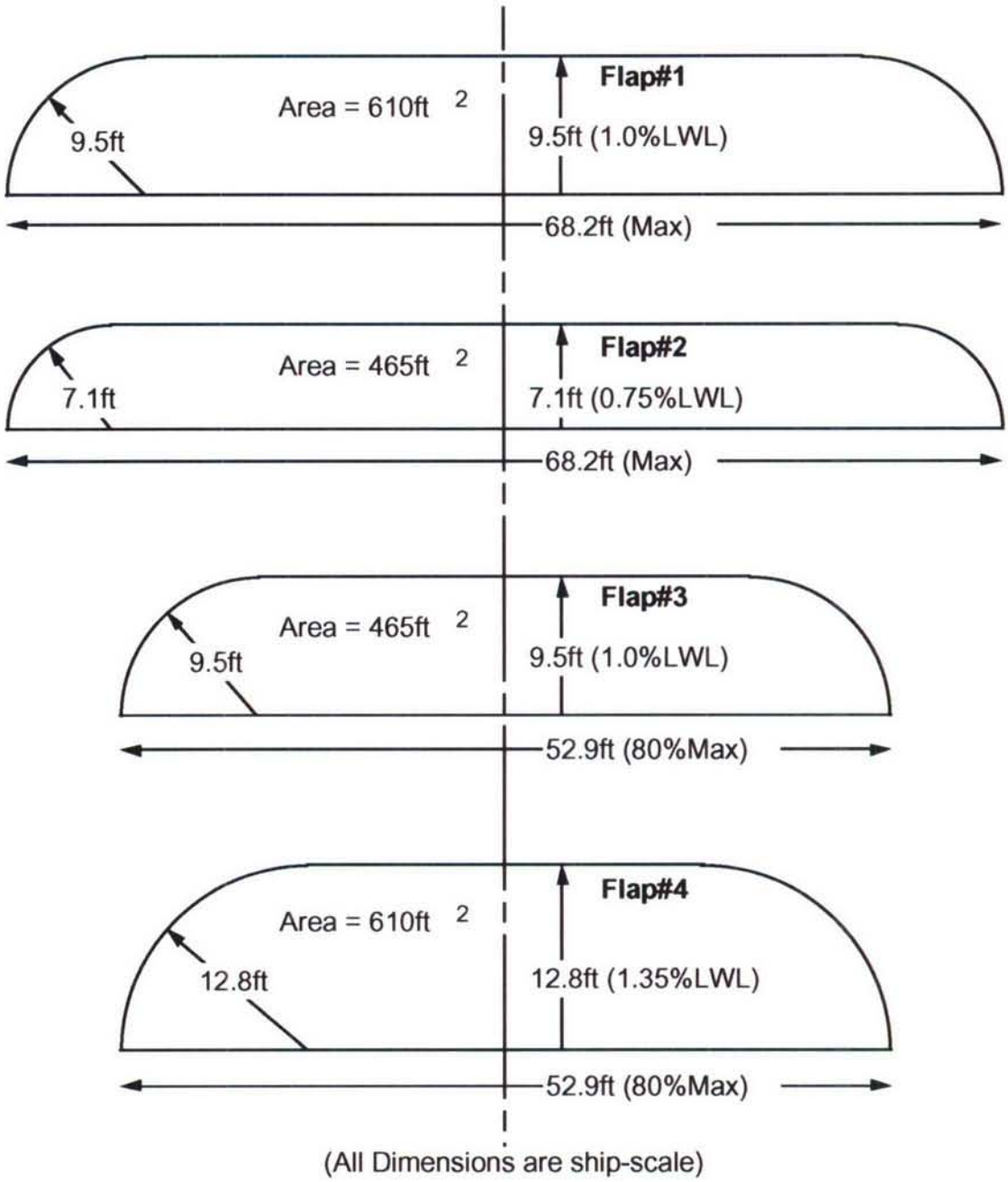


Fig B3. Sketch of candidate stern flap designs tested on JHSS BSS Model 5653-3

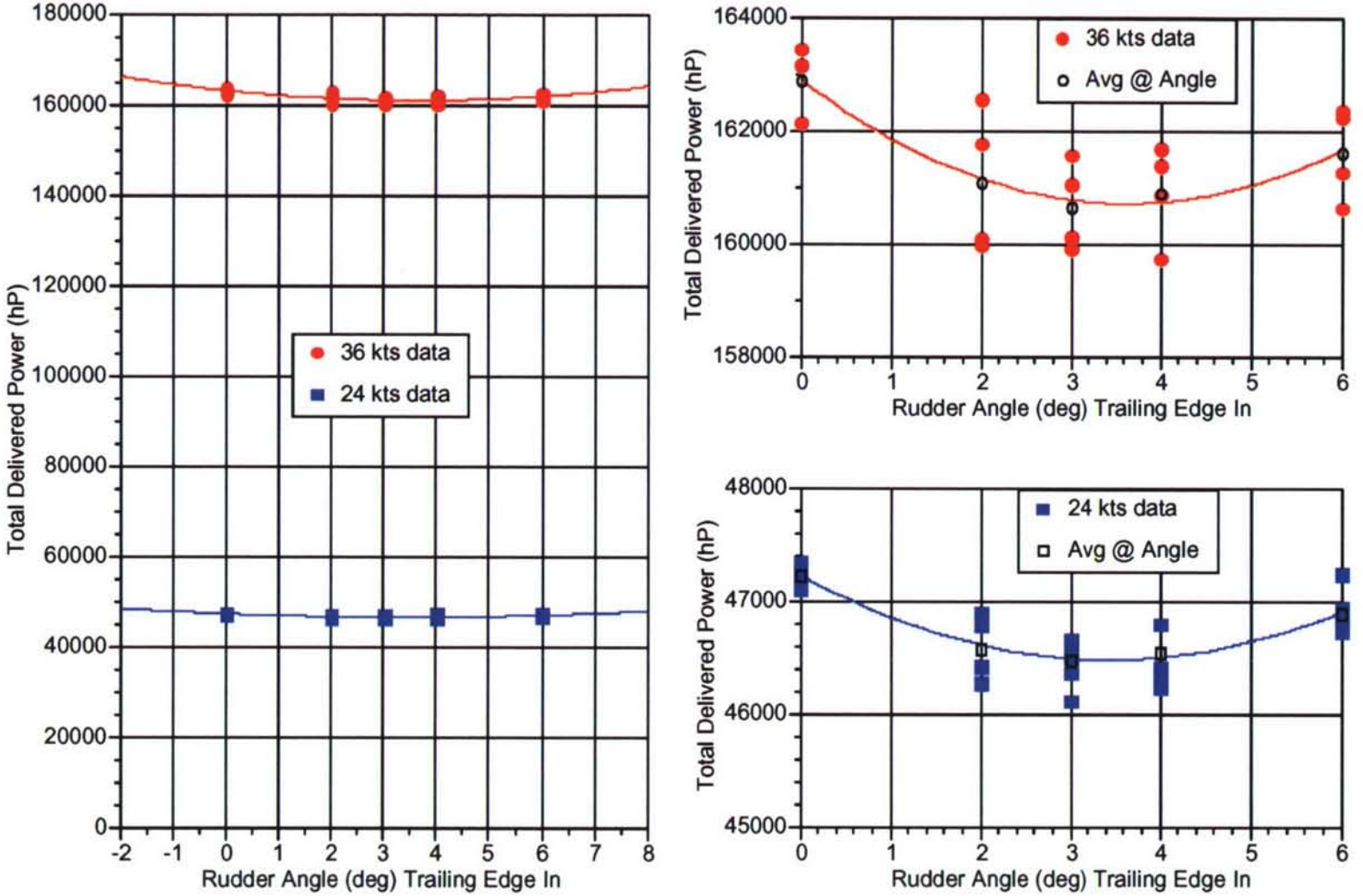


Fig B4. JHSS BSS GB, powered rudder angle optimization

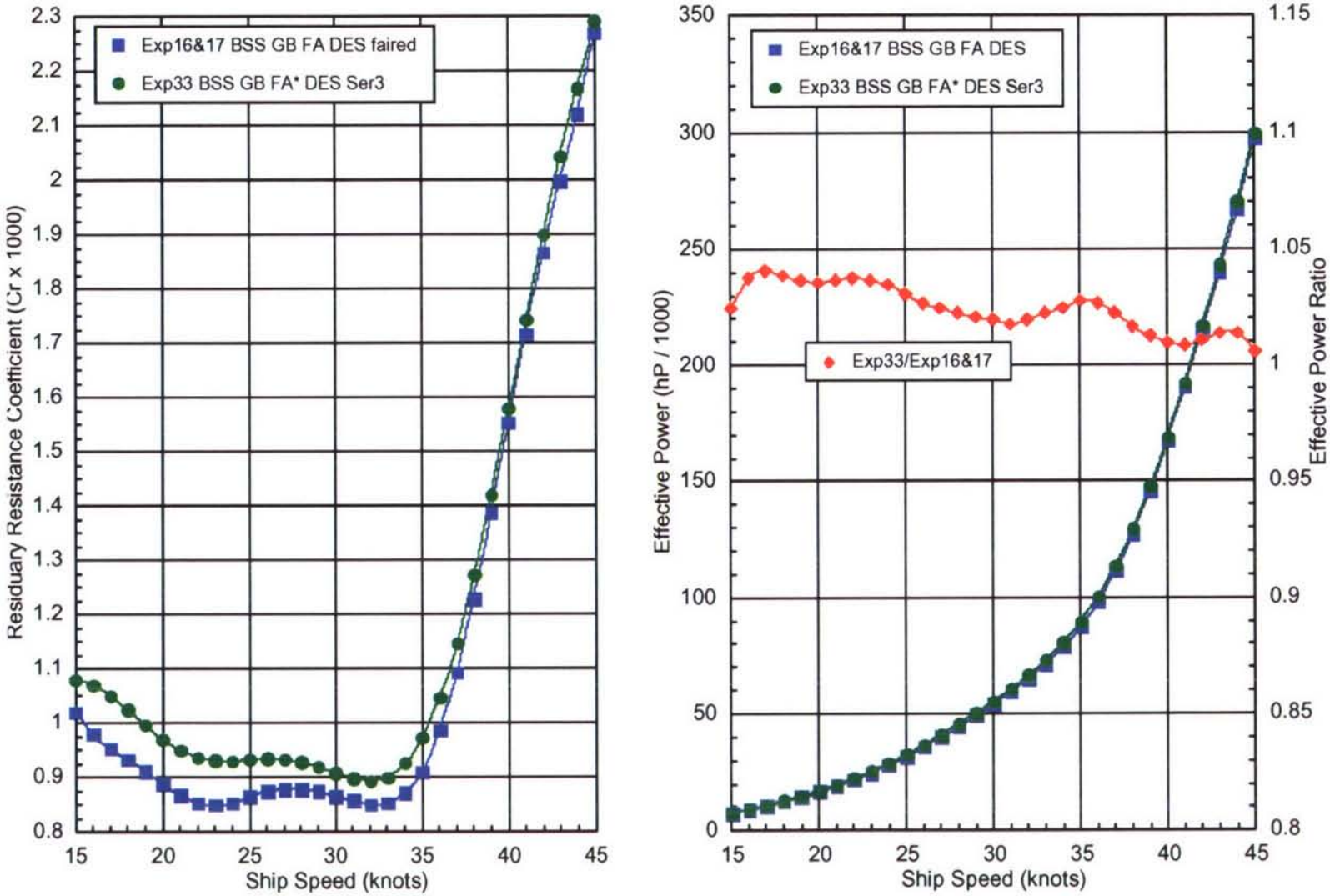
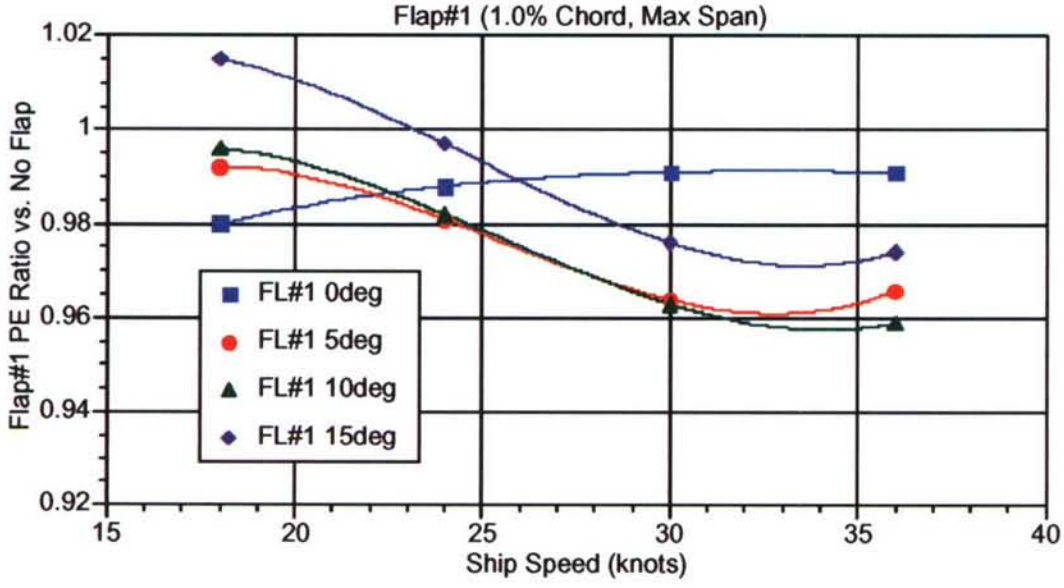
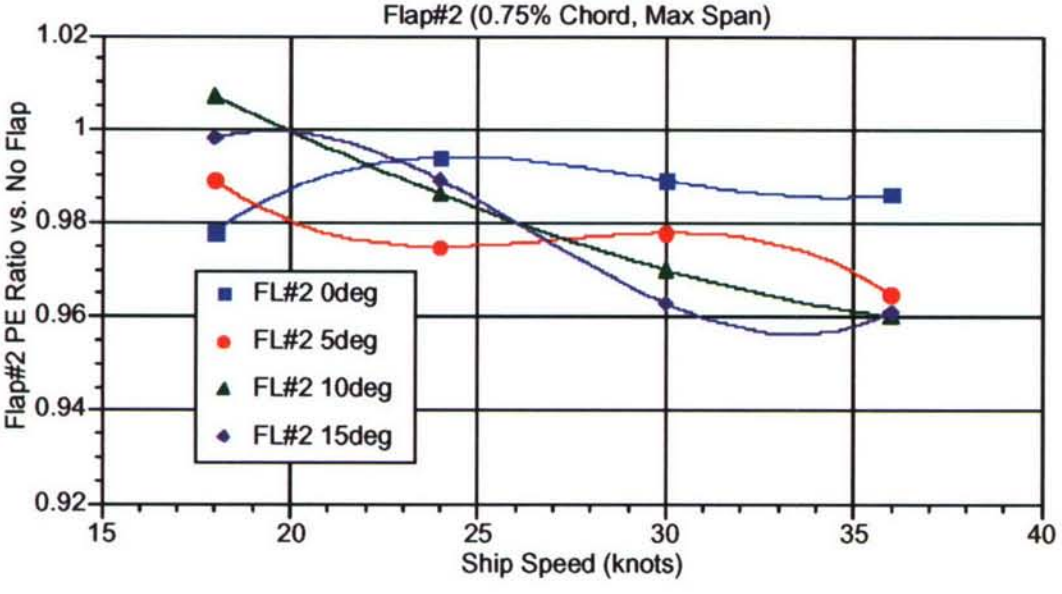
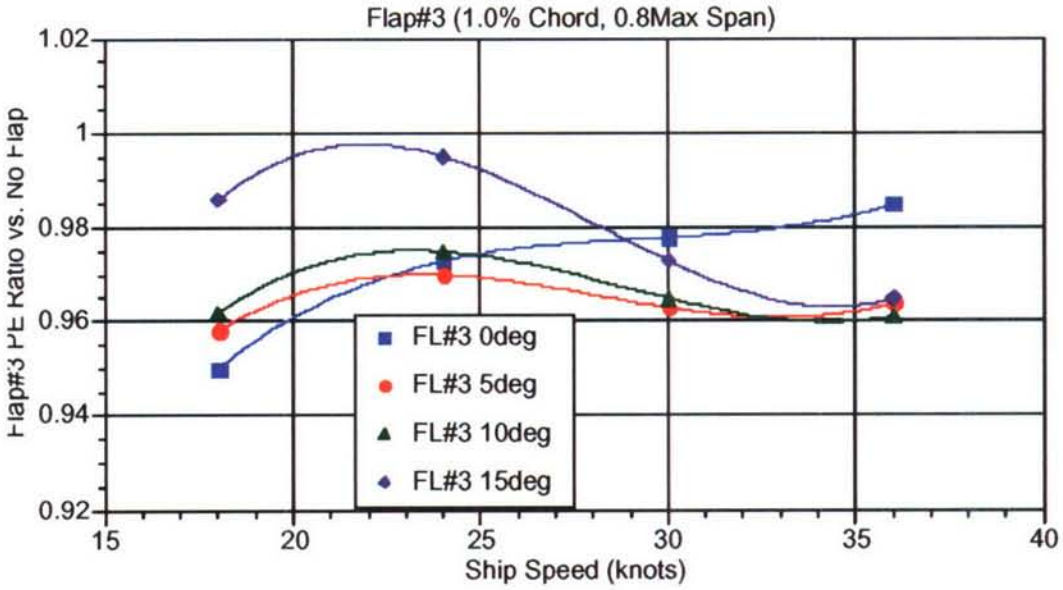


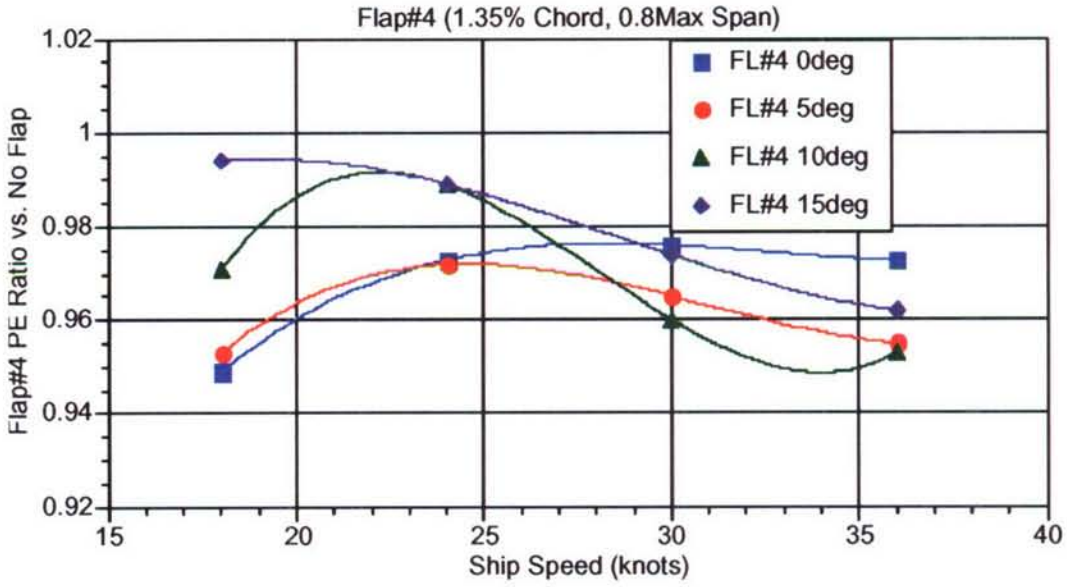
Fig B5. JHSS BSS GB FA DES, Exp33, residuary resistance coefficient and effective power





B6. JHSS BSS GB FA DES, stern flap optimization, effective power ratios





B6. JHSS BSS GB FA DES, stern flap optimization, effective power ratios (continued)

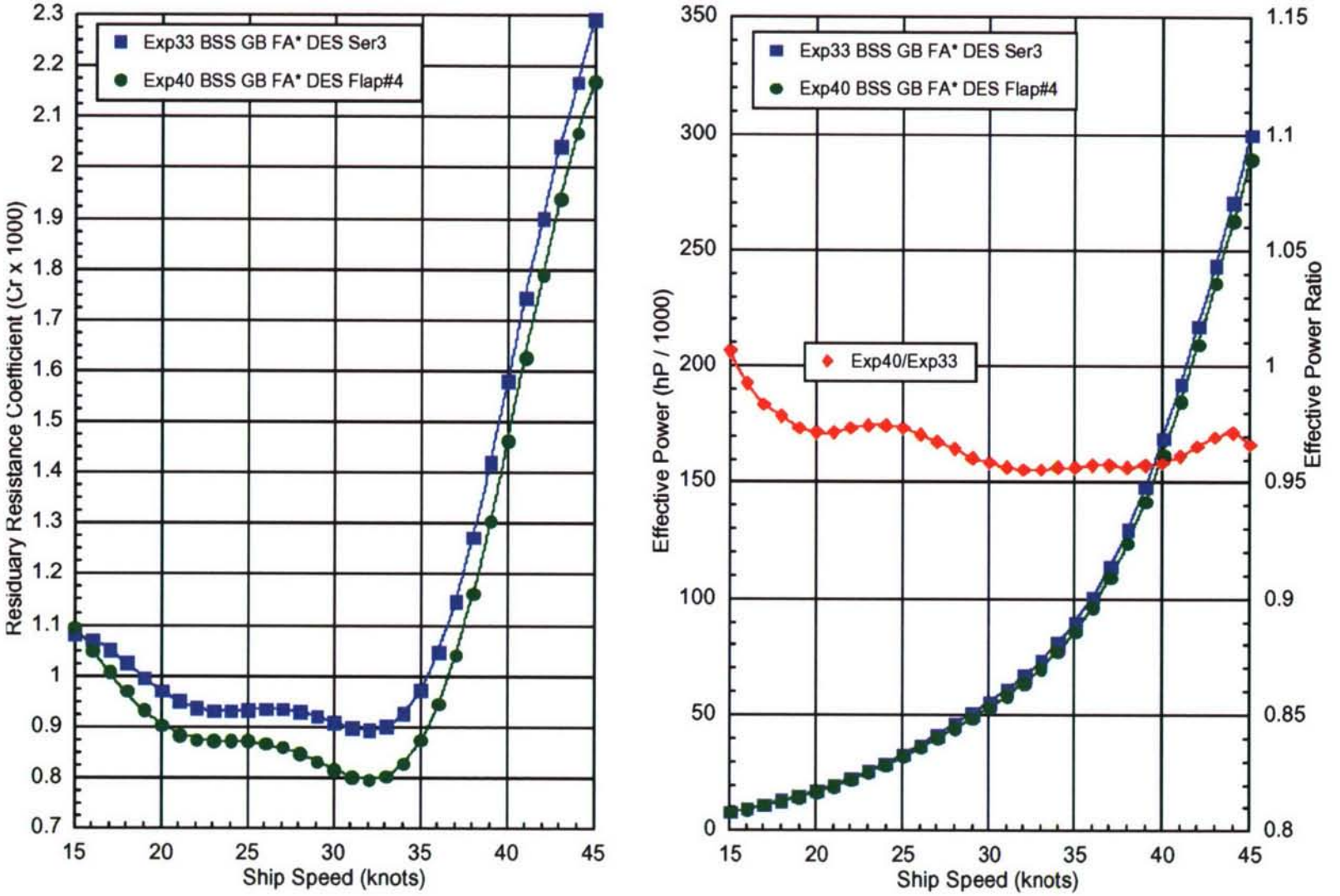


Fig B7. JHSS BSS GB FA DES, Flap#4 @10°, Exp40, residuary resistance coefficient and effective power

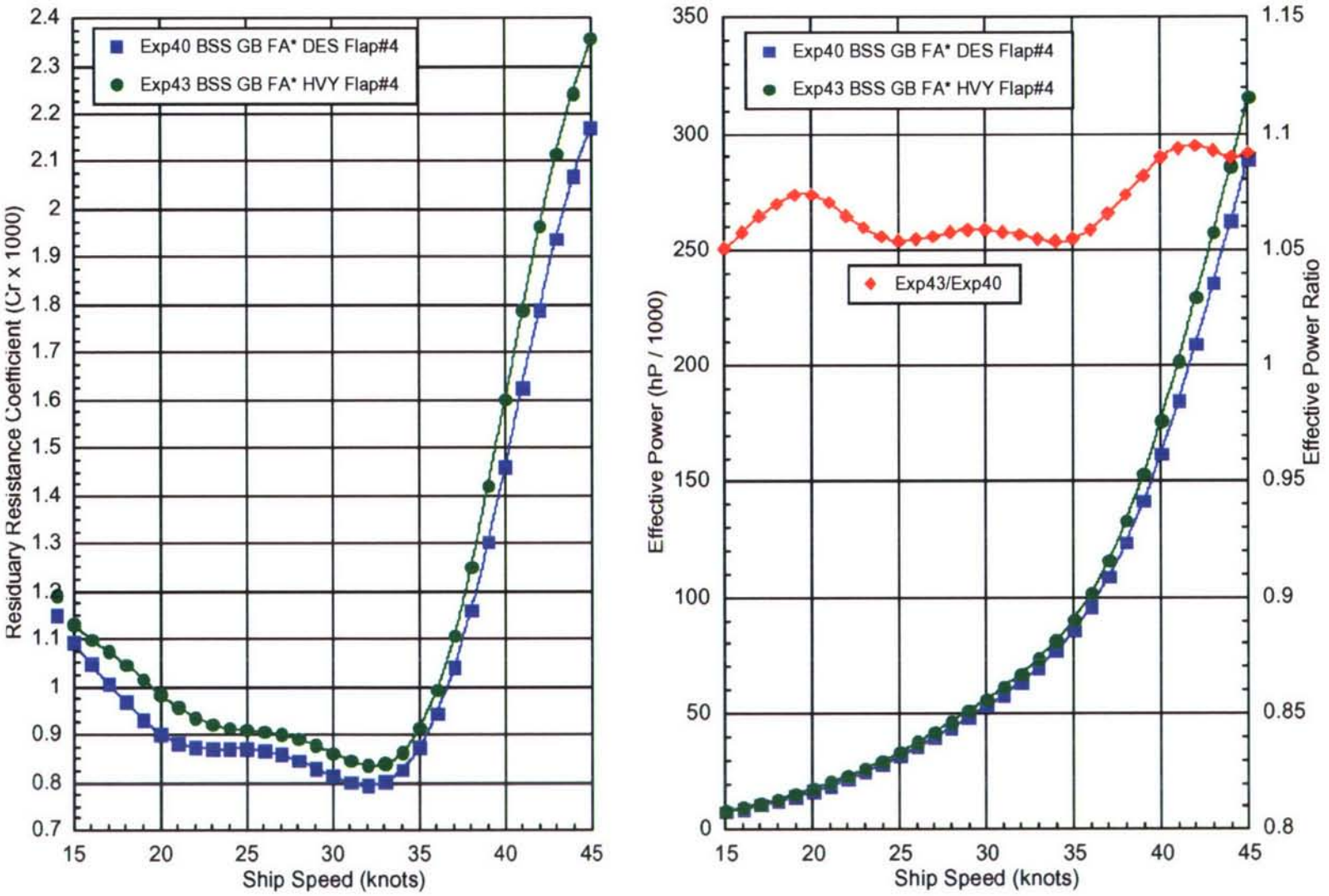


Fig B8. JHSS BSS GB FA HVY, Flap#4 @10°, Exp43, residuary resistance coefficient and effective power

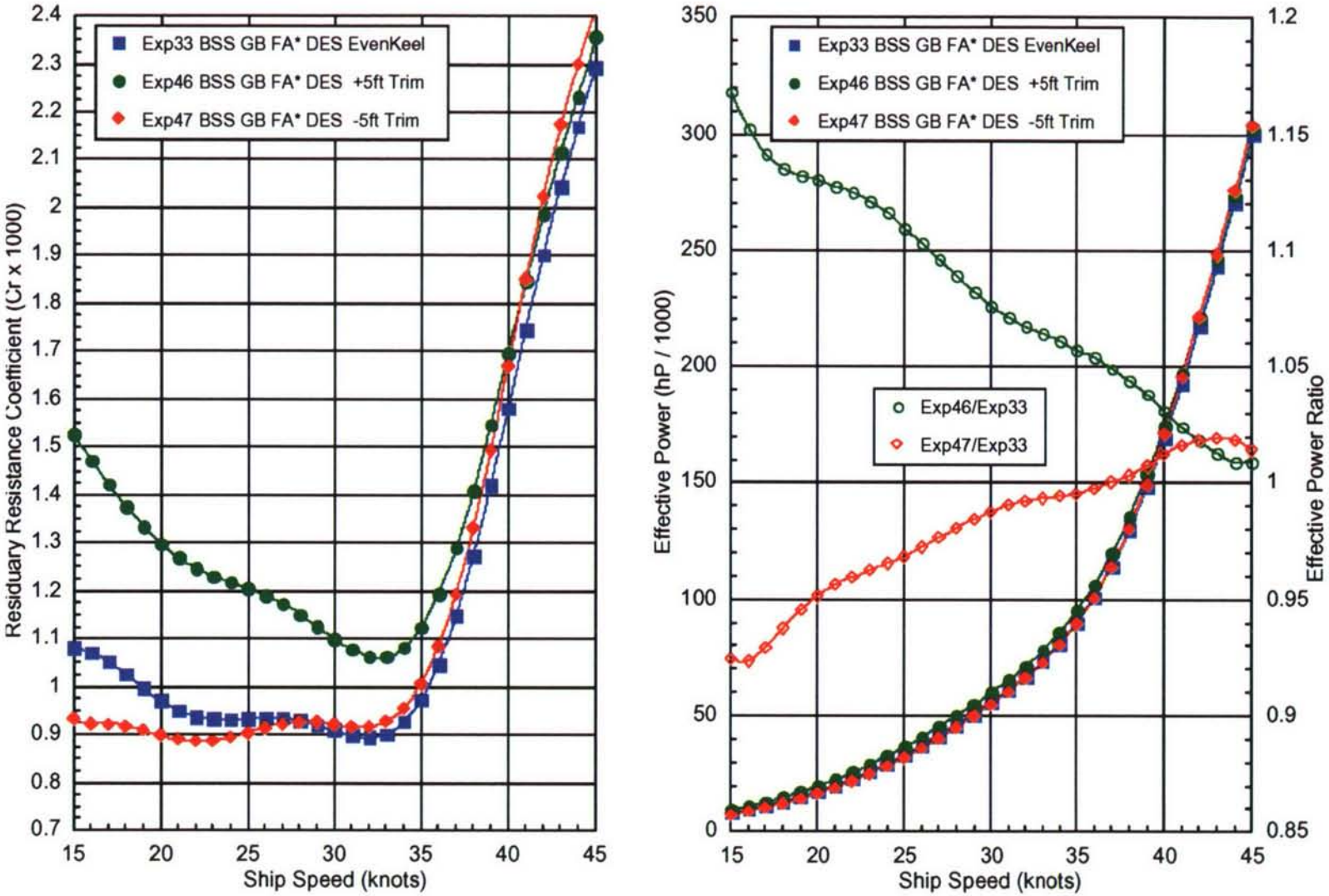


Fig B9. JHSS BSS GB FA DES, ±5ft Trim, Exps 46 & 47, residuary resistance coefficient and effective power

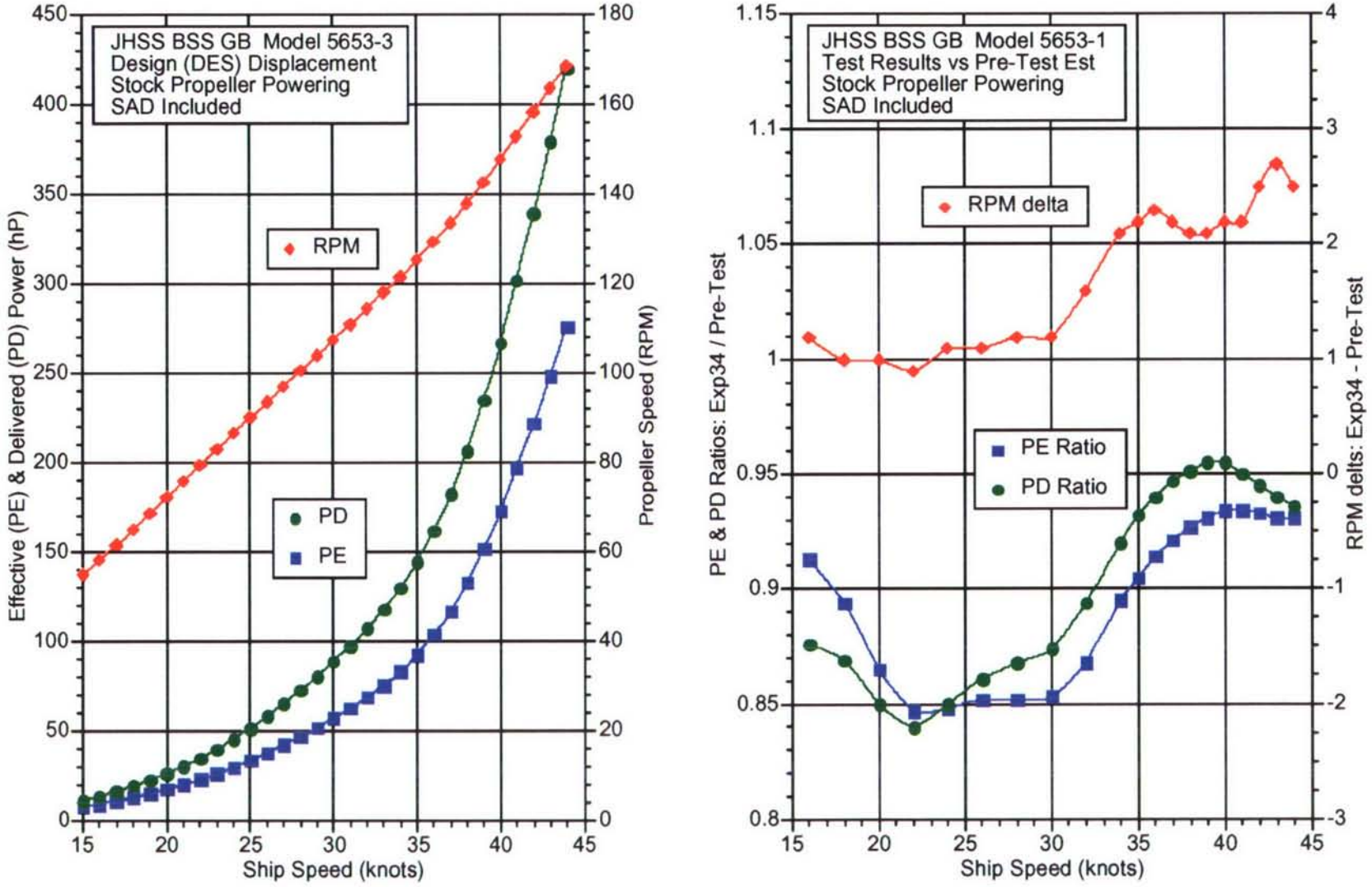


Fig B10. JHSS BSS GB FA DES, stock propeller powering prediction, SAD included

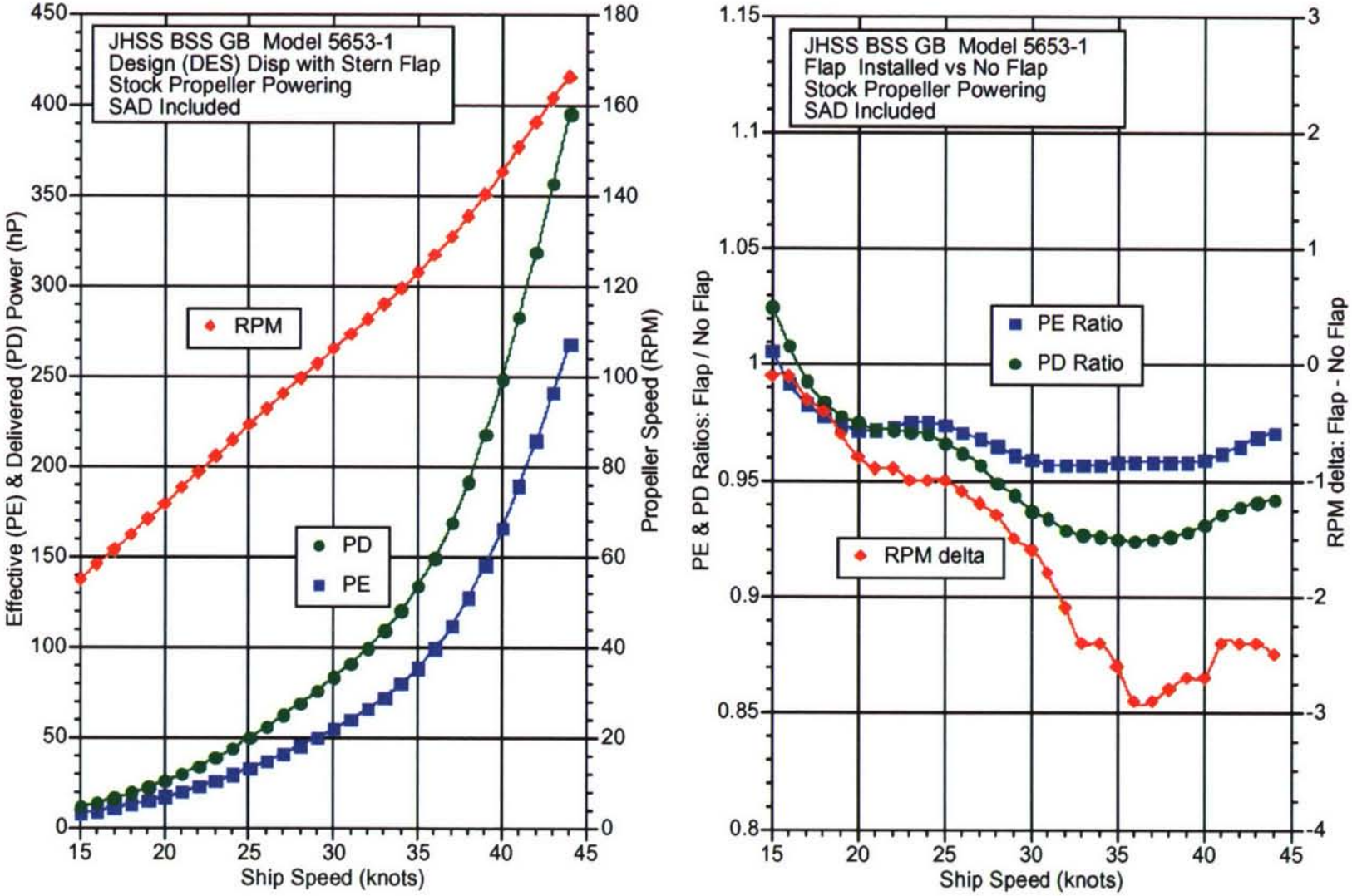


Fig B11. JHSS BSS GB FA DES, Flap#4 @10°, stock propeller powering prediction, SAD included

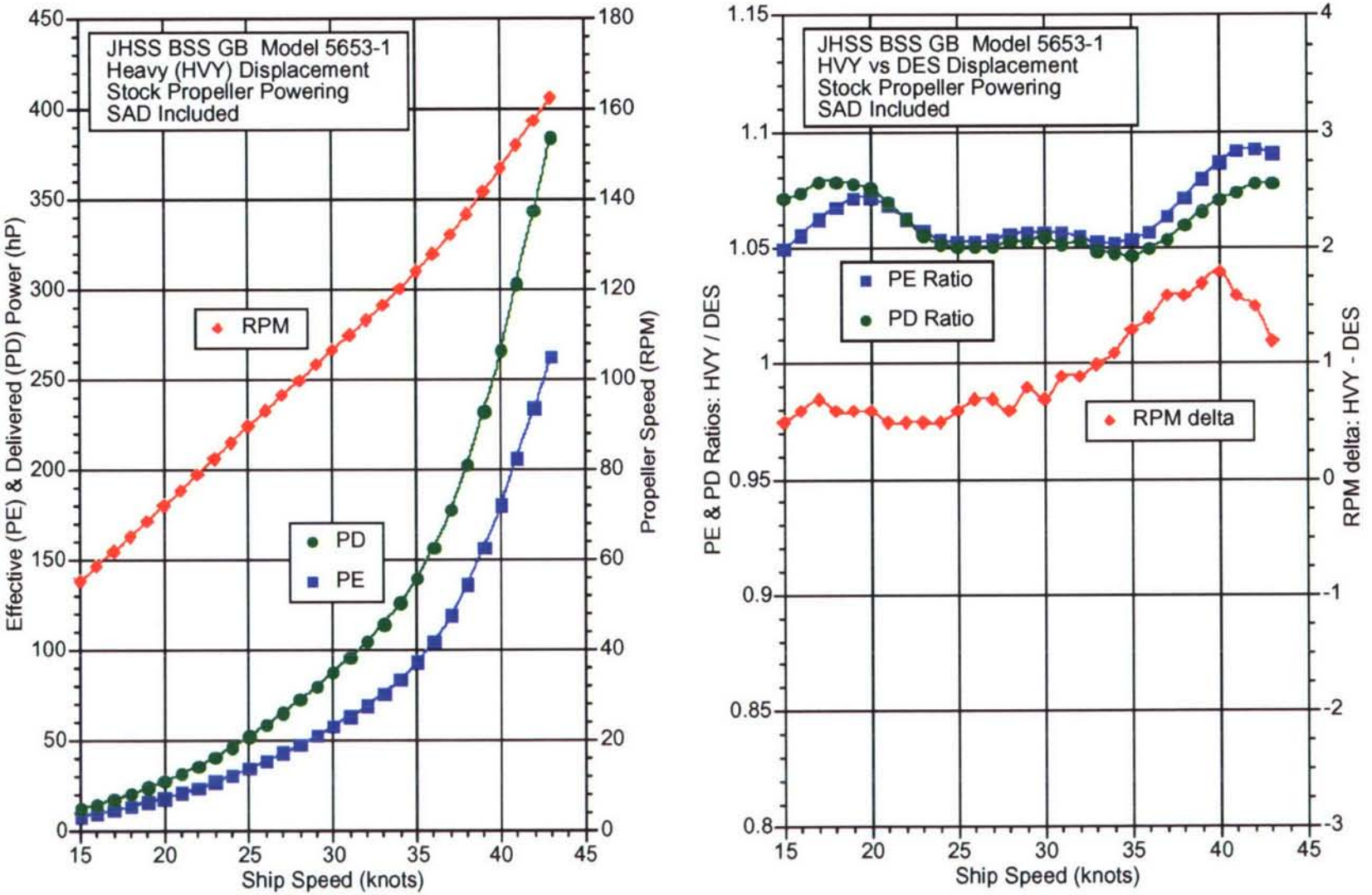


Fig B12. JHSS BSS GB FA HVY, Flap#4 @10°, stock propeller powering prediction, SAD included

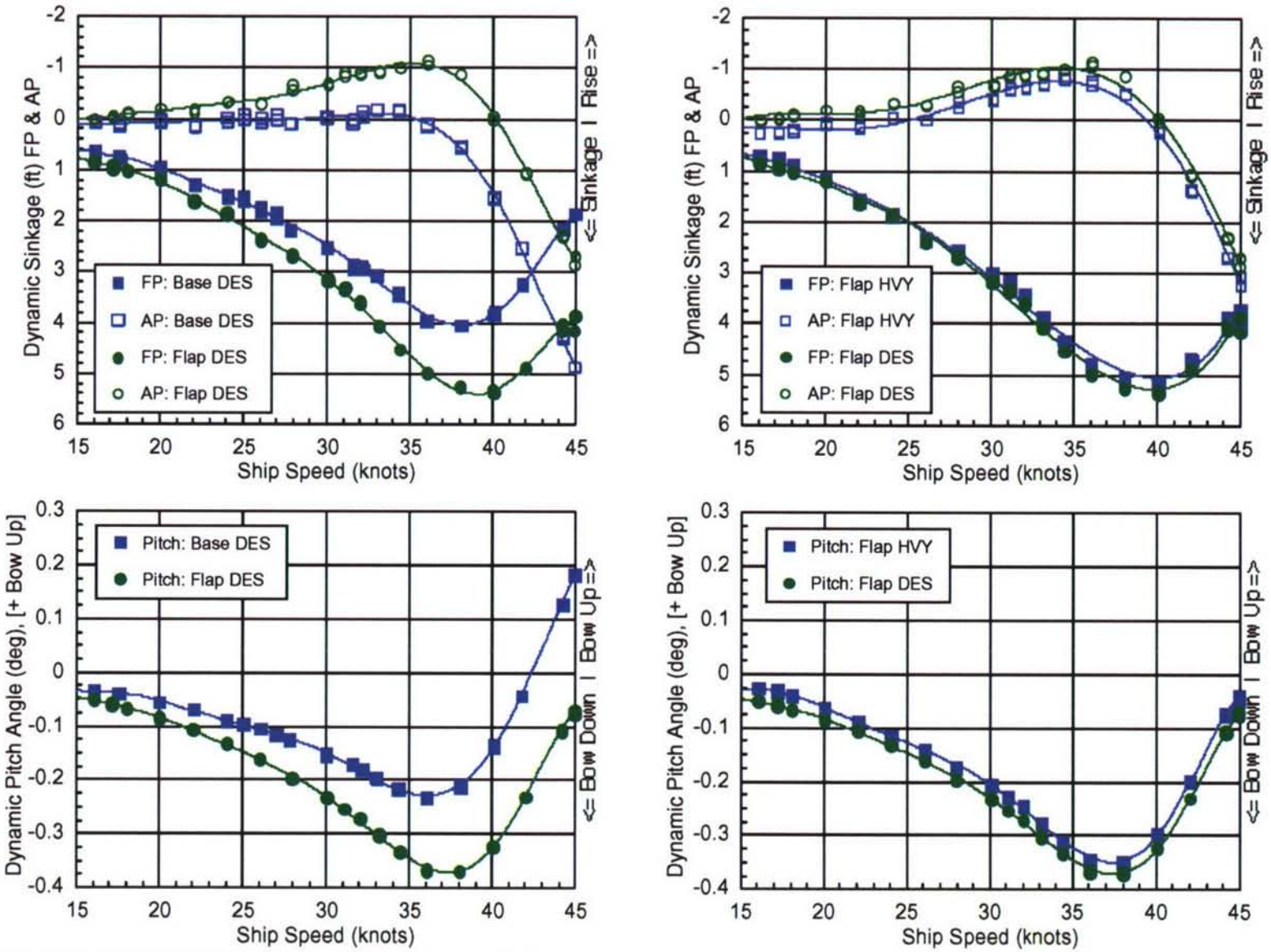


Fig B13. JHSS BSS GB FA, dynamic sinkage and trim

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Table B1. Test Agenda: JHSS BSS GB, Series 3, stock propeller powering tests

Date	Test #	Test Type	Model Number	Stern	Bow	Propul-sion	Append-ages	Loading	Draft (ft) FP	Draft (ft) AP	Speeds (knots)	Comments
	-	Set-up	5653-3	BSS	GB	n/a	FA+	DES	28.8	28.8	n/a	Ballast model. Install model, hardware, software, electronics on Carriage. System check-outs.
17-Oct	30	Alignment	5653-3	BSS	GB	n/a	FA+	DES	28.8	28.8	30	Check-out hardware, data collection, model alignment
17-Oct	31	-	5653-3	BSS	GB	-	FA+	DES	28.8	28.8	-	Aborted. Software and hardware malfunctions.
18-Oct	32	Rudder Angle Optimization	5653-3	BSS	GB	Series 5233-5	FA+	DES	28.8	28.8	24, 36	2 speeds. Optimize rudder angle for minimum PD.
18-Oct	33	Resistance	5653-3	BSS	GB	n/a	FA+	DES	28.8	28.8	15-45	Rudders set to optimized alignment angle for this test
18-Oct	34	Stock Power	5653-3	BSS	GB	Series 5233-5	FA+	DES	28.8	28.8	15-45	forward. Fully appened baseline. 2-knot increments
19-Oct	35	Flap (PE) Optimization	5653-3	BSS	GB	n/a	FA+, SF2	DES	28.8	28.8	24, 30, 36	All flaps tested at 4 angles (0, 5, 10, 15). Max span.
19-Oct	36	Flap (PE) Optimization	5653-3	BSS	GB	n/a	FA+, SF1	DES	28.8	28.8	24, 30, 36	*(increased chord at max span)*
19-Oct	37	Flap (PE) Optimization	5653-3	BSS	GB	n/a	FA+, SF2	DES	28.8	28.8	24, 30, 36	*Contiuation of Test35*
19-Oct	38	Flap (PE) Optimization	5653-3	BSS	GB	n/a	FA+, SF3	DES	28.8	28.8	24, 30, 36	*(reduced span)*
20-Oct	39	Flap (PE) Optimization	5653-3	BSS	GB	n/a	FA+, SF4	DES	28.8	28.8	24, 30, 36	*(increased chord at reduced span)*
20-Oct	-	Stern Flap Selection		-	-	-	-	-	-	-	-	Selection Criteria (Note 4) based on 36 kt data
20-Oct	40	Stern Flap Resistance	5653-3	BSS	GB	n/a	FA+, SF4@10°	DES	28.8	28.8	15-45	Optimum stern flap and angle.
23-Oct	41	Stock Power with Flap	5653-3	BSS	GB	Series 5233-5	FA+, SF4@10°	DES	28.8	28.8	15-45	
23-Oct	-	Model Change	5653-3	BSS	GB	n/a	FA, SF4@10°	DES	28.8	28.8	n/a	Expansion Rings removed. Smaller diameter propeller hubs installed.
23-Oct	42	Resistance	5653-3	BSS	GB	n/a	FA, SF4@10°	DES	28.8	28.8	15-45	Determination of Added PE (if measurable) of Rings and Expanded diameter Prop Hubs.
23-Oct	-	Model Change	5653-3	BSS	GB	n/a	FA+, SF4@10°	HVY	30.6	30.6	n/a	Increase Ballast to Heavy Diaplacement. Reinstall expansion rings and larger diameter hubs.
24-Oct	43	Stern Flap Resistance	5653-3	BSS	GB	n/a	FA+, SF4@10°	HVY	30.6	30.6	15-45	
24-Oct	44	-	5653-3	BSS	GB	Series 5233-5	FA+, SF4@10°	HVY	30.6	30.6	15-45	Aborted. Software and hardware malfunctions.
24-Oct	45	Stock Power with Flap	5653-3	BSS	GB	Series 5233-5	FA+, SF4@10°	HVY	30.6	30.6	15-45	
25-Oct	-	Model Change	5653-3	BSS	GB	n/a	FA+	DES	26.0	31.0	n/a	Remove Flap, Re-ballast, Design disp +5ft Static Trim.

Table B1. Test Agenda: JHSS BSS GB, Series 3, stock propeller powering tests (continued)

Date	Test #	Test Type	Model Number	Stern	Bow	Propul-sion	Append-ages	Loading	Draft (ft) FP	Draft (ft) AP	Speeds (knots)	Comments
25-Oct	46	Resistance	5653-3	BSS	GB	n/a	FA+	DES	26.0	31.0	15-45	Bow Up, bulb exposed, stern submerged deeply.
25-Oct	-	Model Change	5653-3	BSS	GB	n/a	FA+	DES	31.7	26.7	n/a	Re-ballast, Design disp -5ft Static Trim
25-Oct	47	Resistance	5653-3	BSS	GB	n/a	FA+	DES	31.7	26.7	15-45	Bow Down

Notes:
1. BSS: Baseline Shaft & Strut hull. GB: Gooseneck Bulb. DES: Design displacement. HVY: Heavy displacement.
2. FA+ denotes the installation of expansion rings on TE of main strut barrel and (larger diameter) stock propeller hubs. Main strut barrels were designed with diameter smaller than that of stock propeller series 5233-5.
3. FA denotes fully appended with (smaller diameter) propeller hubs matched to main strut barrel diameter (expansion rings not required).
4. Stern Flap Selection Criteria: Establish minimum resistance at 36knots without increasing 24knot resistance by more than 15%.

Table B2. Ship/model test parameters, JHSS BSS GB, Series 3, stock propeller powering tests

Baseline S&S Hull (BSS) Gooseneck Bulb (GB)	Design (DES) 36491 tons		Heavy (HVY) +10% 40140 tons	
Model 5653-3	SHIP	MODEL	SHIP	MODEL
MODEL SCALE RATIO	-	34.121	-	34.121
LOA (ft)	977.5	28.648	977.5	28.648
LBP (ft)	950.5	27.857	950.5	27.857
LWL (ft)	977.9	28.659	947.9	27.781
WET SURF HULL(sq ft)	105221	90.377	108840	93.486
WET SURF APP(sq ft)	1624	1.394	1624	1.394
TOTAL WET SURF(sq ft)	106845	91.772	110464	94.880
DISPLACEMENT (ton, lbs)	36491	2000	40140	2200
BOW DRAFT @FP (ft)	28.82	0.845	30.57	0.896
STERN DRAFT @AP (ft)	28.82	0.845	30.57	0.896
SHIP TRIM (+ft bow up)	0.00	0.000	0.00	0.000
TRIM ANGLE (degrees)	0.00		0.00	
BEAM (ft)	105.0	3.076	105.1	3.079
TEMP (F)	59	70	59	70
RHO	1.9905	1.9362	1.9905	1.9362
NU	1.2817	1.0552	1.2817	1.0552
Bow Deck/Keel (ft)	71.7	2.103	71.7	2.103
Pos of Hook fwd of FP (ft)	37.0	1.083	0.0	0.000
Stern Deck/Keel (ft)	71.0	2.082	71.0	2.082
Pos of Hook aft of AP (ft)	0.0	0.000	0.0	0.000
BOW HOOK SETTING (ft)		1.258		1.207
Hook if at FP (ft)	-	1.258	-	1.207
Hook if at AP (ft)	-	1.237	-	1.186
STERN HOOK SETTING (ft)		1.237		1.186
PROP DIA (ft, in)	21.33	7.500	21.33	7.500
PROP ROTATION	OTBD	OTBD	OTBD	OTBD
SPEED RANGE, min (kts)	15.0	2.57	15.0	2.57
Design Speed (kts)	36.0	6.16	36.0	6.16
max (kts)	45.0	7.70	45.0	7.70
MODEL DISP desired (lbs)		2000		2200
DISP actual (ton, lbs)	36485	2000	40134	2200
MODEL WEIGHT (lbs)	-	919	-	919
Floating Platform (lbs)	-	45	-	45
BALLAST required (lbs)	-	1036	-	1236
delta DISP (ton, lbs)				+200
				+10.0%
APPENDAGES, ws (sqft)	1623.5	1.394	1623.5	1.394
*Rudders (2), redesigned	1623.5	1.394	1623.5	1.394

*Calculated from Rhino surface file

Model Prop Lineup (Left-to-Right)	PO	PI	SI	SO
	5233A	5235	5234A	5234
	LH	LH	RH	RH

Table B2. Ship/model test parameters, JHSS BSS GB, Series 3, stock propeller powering tests (continued)

Baseline S&S Hull (BSS) Gooseneck Bulb (GB)	Design (DES) Bow UP +5ft 36491 tons		Design (DES) Bow DOWN -5ft 36491 tons	
Model 5653-3	SHIP	MODEL	SHIP	MODEL
MODEL SCALE RATIO	-	34.121	-	34.121
LOA (ft)	977.5	28.648	977.5	28.648
LBP (ft)	950.5	27.857	950.5	27.857
LWL (ft)	982.0	28.781	942.4	27.620
WET SURF HULL(sq ft)	104278	89.567	103004	88.473
WET SURF APP(sq ft)	1624	1.394	1624	1.394
TOTAL WET SURF(sq ft)	105902	90.962	104628	89.867
DISPLACEMENT (ton, lbs)	36491	2000	36491	2000
BOW DRAFT @FP (ft)	26.03	0.763	31.68	0.928
STERN DRAFT @AP (ft)	31.03	0.909	26.68	0.782
SHIP TRIM (+ft bow up)	5.00	0.147	-5.00	-0.147
TRIM ANGLE (degrees)	0.30		-0.30	
BEAM (ft)	105.0	3.076	105.0	3.076
TEMP (F)	59	70	59	70
RHO	1.9905	1.9362	1.9905	1.9362
NU	1.2817	1.0552	1.2817	1.0552
Bow Deck/Keel (ft)	71.7	2.103	71.7	2.103
Pos of Hook fwd of FP (ft)	37.0	1.083	37.0	1.083
Stern Deck/Keel (ft)	71.0	2.082	71.0	2.082
Pos of Hook aft of AP (ft)	0.0	0.000	0.0	0.000
BOW HOOK SETTING (ft)		**1.334**		1.180
Hook if at FP (ft)	-	1.340	-	1.174
Hook if at AP (ft)	-	1.173	-	1.300
STERN HOOK SETTING (ft)		**1.173**		1.300
PROP DIA (ft, in)	21.33	7.500	21.33	7.500
PROP ROTATION	OTBD	OTBD	OTBD	OTBD
SPEED RANGE, min (kts)	15.0	2.57	15.0	2.57
Design Speed (kts)	36.0	6.16	36.0	6.16
max (kts)	45.0	7.70	45.0	7.70
MODEL DISP desired (lbs)		2000		2000
DISP actual (ton, lbs)	4469	245	5746	315
MODEL WEIGHT (lbs)	-	0	-	0
Floating Platform (lbs)	-	45	-	45
BALLAST required (lbs)	-	200	-	270
delta DISP (ton, lbs)				
APPENDAGES, ws (sqft)	1623.5	1.394	1623.5	1.394
*Rudders (2), redesigned	1623.5	1.394	1623.5	1.394

*Calculated from Rhino surface file

Model Prop Lineup (Left-to-Right)	PO	PI	SI	SO
	5233A LH	5235 LH	5234A RH	5234 RH

B3a. Open water performance characteristics, stock propellers 5233A and 5234A

5233A

FAIRED OPEN WATER COEFFICIENTS FOR PROPELLER 5233A

PC - 1 | 19 DEC. 1994 | EXP. NO. 2

J	KT	10KQ	no
0.000	0.8368	1.6834	0.000
0.050	0.8172	1.6388	0.040
0.100	0.7945	1.5885	0.080
0.150	0.7691	1.5342	0.120
0.200	0.7418	1.4773	0.160
0.250	0.7132	1.4191	0.200
0.300	0.6835	1.3605	0.240
0.350	0.6534	1.3024	0.279
0.400	0.6230	1.2453	0.318
0.450	0.5927	1.1899	0.357
0.500	0.5628	1.1364	0.394
0.550	0.5333	1.0850	0.430
0.600	0.5044	1.0358	0.465
0.650	0.4762	0.9888	0.498
0.700	0.4488	0.9438	0.530
0.750	0.4220	0.9006	0.559
0.800	0.3960	0.8588	0.587
0.850	0.3705	0.8182	0.613
0.900	0.3456	0.7782	0.636
0.950	0.3210	0.7385	0.657
1.000	0.2966	0.6984	0.676
1.050	0.2721	0.6575	0.692
1.100	0.2476	0.6152	0.704
1.150	0.2225	0.5711	0.713
1.200	0.1969	0.5246	0.717
1.250	0.1703	0.4753	0.713
1.300	0.1426	0.4227	0.698
1.350	0.1136	0.3665	0.666
1.400	0.0828	0.3064	0.602
1.450	0.0502	0.2420	0.478
1.500	0.0153	0.1734	0.211

MODEL PROPELLER CHARACTERISTICS

	DIAMETER	CHORD LENGTH @ 0.7R
inches	7.500	3.465
mm	190.500	88.011

P/D @ 0.7R	NO. BLADES	ROTATION
1.449	6	LH

5234A

FAIRED OPEN WATER COEFFICIENTS FOR PROPELLER 5234A

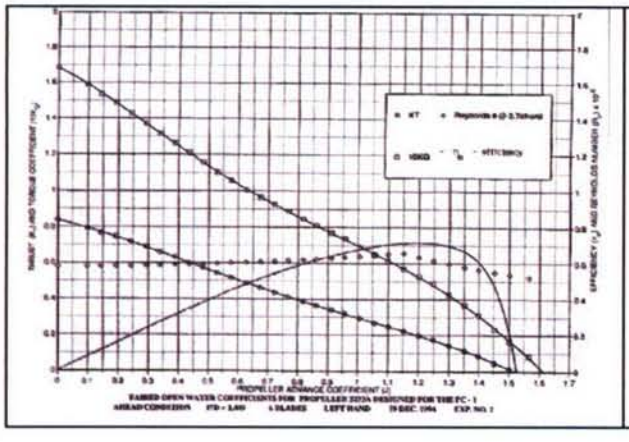
PC - 1 | 20 DEC. 1994 | EXP. NO. 2

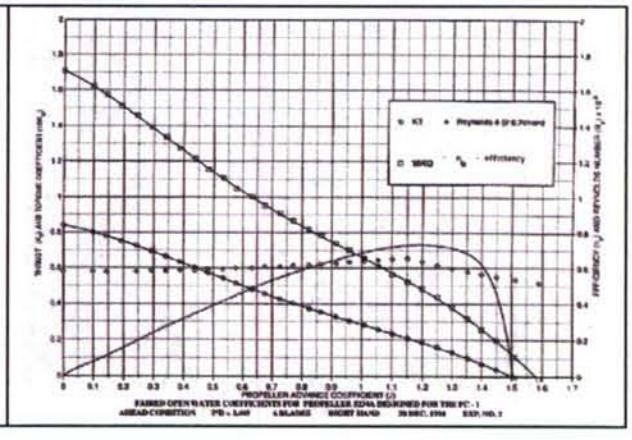
J	KT	10KQ	no
0.000	0.841	1.710	0.000
0.050	0.824	1.667	0.039
0.100	0.802	1.617	0.079
0.150	0.777	1.563	0.119
0.200	0.749	1.504	0.159
0.250	0.720	1.444	0.198
0.300	0.689	1.383	0.238
0.350	0.658	1.321	0.277
0.400	0.626	1.260	0.316
0.450	0.594	1.200	0.354
0.500	0.562	1.142	0.392
0.550	0.531	1.086	0.428
0.600	0.500	1.032	0.463
0.650	0.471	0.980	0.497
0.700	0.442	0.930	0.529
0.750	0.414	0.883	0.560
0.800	0.387	0.836	0.588
0.850	0.360	0.792	0.615
0.900	0.334	0.748	0.641
0.950	0.309	0.705	0.663
1.000	0.284	0.661	0.684
1.050	0.259	0.618	0.702
1.100	0.235	0.573	0.716
1.150	0.209	0.527	0.727
1.200	0.184	0.479	0.732
1.250	0.157	0.429	0.729
1.300	0.130	0.375	0.715
1.350	0.101	0.318	0.680
1.400	0.070	0.257	0.608
1.450	0.038	0.192	0.456
1.500	0.004	0.123	0.071

MODEL PROPELLER CHARACTERISTICS

	DIAMETER	CHORD LENGTH @ 0.7R
inches	7.500	3.465
mm	190.500	88.011

P/D @ 0.7R	NO. BLADES	ROTATION
1.449	6	RH





B3b. Open water performance characteristics, stock propellers 5234 and 5235

5234

FAIRED OPEN WATER COEFFICIENTS FOR PROPELLER 5234

PC - 1 **20 DEC. 1994** **EXP. NO. 3**

J	KT	10KQ	no
0.000	0.832	1.676	0.000
0.050	0.813	1.632	0.040
0.100	0.791	1.582	0.080
0.150	0.766	1.528	0.120
0.200	0.740	1.472	0.160
0.250	0.711	1.413	0.200
0.300	0.682	1.354	0.240
0.350	0.651	1.295	0.280
0.400	0.621	1.236	0.320
0.450	0.590	1.179	0.358
0.500	0.559	1.123	0.396
0.550	0.528	1.069	0.433
0.600	0.498	1.016	0.468
0.650	0.469	0.966	0.502
0.700	0.440	0.917	0.534
0.750	0.412	0.870	0.565
0.800	0.385	0.825	0.593
0.850	0.358	0.781	0.620
0.900	0.332	0.738	0.644
0.950	0.307	0.696	0.666
1.000	0.282	0.654	0.686
1.050	0.257	0.611	0.703
1.100	0.232	0.568	0.716
1.150	0.207	0.523	0.725
1.200	0.182	0.477	0.729
1.250	0.156	0.428	0.724
1.300	0.128	0.377	0.705
1.350	0.100	0.322	0.664
1.400	0.069	0.264	0.580
1.450	0.035	0.201	0.406

MODEL PROPELLER CHARACTERISTICS

	DIAMETER	CHORD LENGTH @ 0.7R
inches	7.500	3.465
mm	190.500	88.011

P/D @ 0.7R	NO. BLADES	ROTATION
1.449	6	RH

5235

FAIRED OPEN WATER COEFFICIENTS FOR PROPELLER 5235

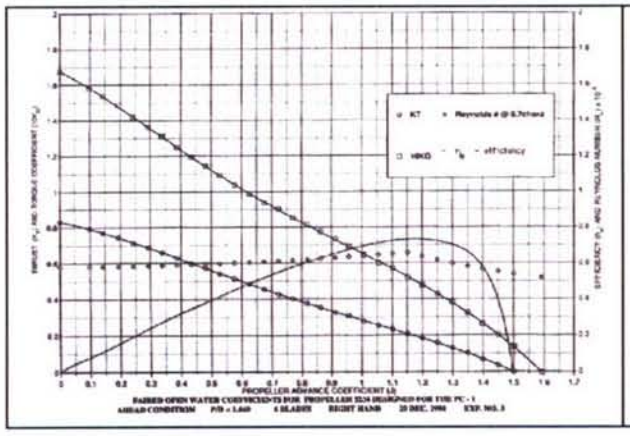
PC - 1 **20 DEC. 1994** **EXP. NO. 3**

J	KT	10KQ	no
0.000	0.811	1.641	0.000
0.050	0.795	1.602	0.039
0.100	0.776	1.558	0.079
0.150	0.754	1.509	0.119
0.200	0.730	1.457	0.159
0.250	0.703	1.403	0.199
0.300	0.676	1.348	0.239
0.350	0.647	1.293	0.279
0.400	0.618	1.238	0.318
0.450	0.589	1.185	0.356
0.500	0.559	1.133	0.393
0.550	0.530	1.082	0.429
0.600	0.502	1.033	0.464
0.650	0.474	0.987	0.497
0.700	0.447	0.941	0.529
0.750	0.420	0.898	0.558
0.800	0.394	0.856	0.586
0.850	0.369	0.814	0.612
0.900	0.344	0.774	0.636
0.950	0.319	0.733	0.658
1.000	0.295	0.692	0.678
1.050	0.270	0.651	0.695
1.100	0.246	0.608	0.709
1.150	0.221	0.563	0.719
1.200	0.195	0.516	0.724
1.250	0.169	0.466	0.721
1.300	0.141	0.413	0.708
1.350	0.112	0.356	0.676
1.400	0.081	0.295	0.612
1.450	0.048	0.229	0.482
1.500	0.012	0.158	0.185

MODEL PROPELLER CHARACTERISTICS

	DIAMETER	CHORD LENGTH @ 0.7R
inches	7.500	3.465
mm	190.500	88.011

P/D @ 0.7R	NO. BLADES	ROTATION
1.449	6	LH



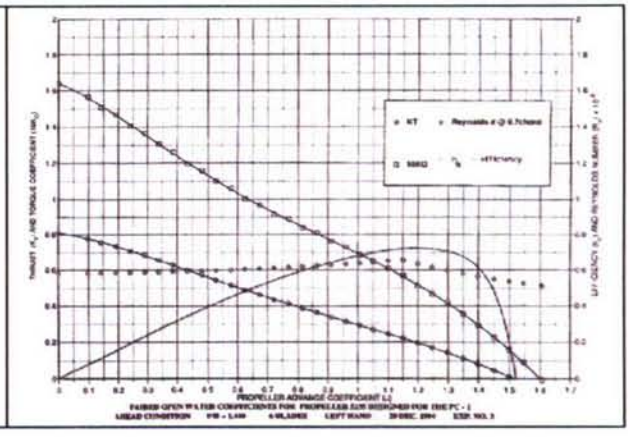


Table B4. Principal dimensions of candidate stern flap designs tested on Model 5653-3

Stern Flap Candidate Ship/Model Principal Dimensions & Parameters				
	Model	34.121	Ship	
LBP	334	inch	950.5	ft
Transom Bx @DWL	27.8	inch	79.0	ft
Flap Max Span*	24	inch	68.2	ft
Max Span (%Bx)	86.4			

*Judgement of Test Engneer to avoide radius at turn of bilge.
Rule of thumb, max span not to excede 0.9Bx

Flap#1	Initial Flap: 1%LBP Chord, Max Span			
Chord (%LBP)	1			
Span (%Bx)	86.4			
Flap Chord	3.34	inch	9.5	ft
Flap Span	24.0	inch	68.2	ft
Flap Area	75.43	sq in	609.8	sq ft

Flap#2	Max Span held constant, Chord reduced to 0.75%LBP			
Chord (%LBP)	0.75			
Span (%Bx)	86.4			
Flap Chord	2.51	inch	7.1	ft
Flap Span	24.0	inch	68.2	ft
Flap Area	57.47	sq in	464.7	sq ft

Flap#3	1%LBP Chord, Span Reduced until Area Equivalent to Flap#2			
Chord (%LBP)	1			
Span (%Bx)	67.0			
Span (% Max)	0.8			
Flap Chord	3.34	inch	9.5	ft
Flap Span	18.6	inch	52.9	ft
Flap Area	57.44	sq in	464.4	sq ft

Flap#4	Reduced Span retained, Chord Increased until Area Equivalent to Flap#1			
Chord (%LBP)	1.35			
Span (%Bx)	67.0			
Span (% Max)	0.8			
Flap Chord	4.51	inch	12.8	ft
Flap Span	18.6	inch	52.9	ft
Flap Area	75.27	sq in	608.6	sq ft

Table B5. JHSS BSS GB FA DES, Exp32, powered rudder angle optimization

Rudder Angle TEI (deg)	24 kts data PD (hP)			Rudder Angle TEI (deg)	36 kts data PD (hP)		
0	47223	47232	PD (hp) Avg	0	163414	162892	PD (hp) Avg
0	47220	86.8	StDev	0	162127	677.2	StDev
0	47211	199.6	Uncertainty	0	163136	1557.6	Uncertainty
0	47091	0.42%	Uncert %			0.96%	Uncert %
0	47314						
0	47334						
2	46847	46577	PD (hp) Avg	2	162535	161078	PD (hp) Avg
2	46415	292.2	StDev	2	161747	1269.9	StDev
2	46262	672.1	Uncertainty	2	160068	2920.8	Uncertainty
2	46275	1.44%	Uncert %	2	159961	1.81%	Uncert %
2	46774						
2	46891						
4	47176	46545	PD (hp) Avg	4	161672	160902	PD (hp) Avg
4	46794	365.7	StDev	4	161364	856.2	StDev
4	46402	841.2	Uncertainty	4	160848	1969.3	Uncertainty
4	46323	1.81%	Uncert %	4	159723	1.22%	Uncert %
4	46228						
4	46349						
6	46881	46889	PD (hp) Avg	6	162333	161612	PD (hp) Avg
6	46939	188.6	StDev	6	162236	819.4	StDev
6	46814	433.8	Uncertainty	6	161256	1884.5	Uncertainty
6	47236	0.93%	Uncert %	6	160623	1.17%	Uncert %
6	46730						
6	46734						
3	**46362**	**46472**	PD (hp) Avg	**3**	**161548**	**160647**	PD (hp) Avg
3	46621	204.6	StDev	3	161035	777.6	StDev
3	46500	470.7	Uncertainty	3	159906	1788.5	Uncertainty
3	46583	1.01%	Uncert %	3	160097	1.11%	Uncert %
3	46112						
3	46652						
		-760.5	PD (hp) Reduction			-2245.8	PD (hp) Reduction
		-1.61%	Reduction %			-1.38%	Reduction %
		511.3	RSS Uncertainty			2371.6	RSS Uncertainty
		1.08%	Uncert %			1.46%	Uncert %

Table B6. JHSS BSS GB FA DES, Exp33, effective power prediction

JHSS Exp33 BSS GB FA* DES (PE from CR input)

	SHIP		MODEL	
LAMBDA			34.121	
LWL	977.9	ft	28.660	ft
S	106845	ft^2	91.772	ft^2
WT	36491	LT	2000.6	lbs
RHO	1.9905	$(lbf*sec^2)/ft^4$	1.9365	$(lbf*sec^2)/ft^4$
NU	1.2817E-05	ft^2/sec	1.0692E-05	ft^2/sec
Ca			0.0000	

Vs	PE		FRICTIONAL POWER		FN	V-L	1000CR
knots	HP	KW	HP	KW			
15.0	7820.9	5832.0	4432.5	3305.3	0.143	0.480	1.080
16.0	9413.2	7019.4	5338.3	3980.8	0.152	0.512	1.070
17.0	11156.7	8319.6	6357.3	4740.6	0.162	0.544	1.051
18.0	13050.5	9731.7	7495.6	5589.5	0.171	0.576	1.025
19.0	15111.0	11268.3	8759.6	6532.1	0.181	0.608	0.996
20.0	17370.1	12952.9	10155.5	7572.9	0.190	0.640	0.970
21.0	19867.8	14815.5	11689.3	8716.7	0.200	0.672	0.950
22.0	22644.8	16886.2	13367.2	9967.9	0.209	0.704	0.937
23.0	25732.5	19188.7	15195.3	11331.1	0.219	0.735	0.932
24.0	29146.8	21734.8	17179.6	12810.8	0.228	0.767	0.931
25.0	32883.7	24521.4	19326.2	14411.5	0.238	0.799	0.933
26.0	36920.6	27531.7	21641.0	16137.7	0.247	0.831	0.935
27.0	41223.2	30740.2	24130.1	17993.8	0.257	0.863	0.934
28.0	45758.2	34121.9	26799.4	19984.3	0.266	0.895	0.929
29.0	50510.8	37665.9	29654.8	22113.6	0.276	0.927	0.920
30.0	55505.2	41390.2	32702.2	24386.0	0.285	0.959	0.909
31.0	60825.1	45357.3	35947.6	26806.1	0.295	0.991	0.898
32.0	66630.5	49686.4	39396.8	29378.2	0.304	1.023	0.894
33.0	73167.1	54560.7	43055.6	32106.5	0.314	1.055	0.901
34.0	80762.6	60224.7	46929.9	34995.6	0.324	1.087	0.926
35.0	89808.5	66970.2	51025.4	38049.7	0.333	1.119	0.973
36.0	100723.3	75109.4	55348.1	41273.1	0.343	1.151	1.046
37.0	113898.5	84934.1	59903.7	44670.2	0.352	1.183	1.147
38.0	129630.5	96665.4	64697.8	48245.2	0.362	1.215	1.273
39.0	148049.5	110400.5	69736.4	52002.4	0.371	1.247	1.420
40.0	169059.8	126067.9	75025.1	55946.2	0.381	1.279	1.581
41.0	192319.3	143412.5	80569.6	60080.7	0.390	1.311	1.744
42.0	217293.6	162035.9	86375.6	64410.3	0.400	1.343	1.901
43.0	243439.4	181532.7	92448.8	68939.1	0.409	1.375	2.043
44.0	270582.9	201773.7	98795.0	73671.4	0.419	1.407	2.169
45.0	299587.9	223402.7	105419.7	78611.4	0.428	1.439	2.292

Table B7. JHSS BSS GB FA DES, stern flap optimization, effective power ratios

VS (knots)	Exp33 BSS GB FA* DES No Flap PE (hP)	Exp35 BSS GB FA* DES Flap#2 (0.75% Chord, Max Span) 0 deg TED PE (hP)	5 deg TED PE (hP)	10 deg TED PE (hP)	15 deg TED PE (hP)
18	13046	12765	12906	13017	13139
24	29143	28957	28406	28725	28817
30	55530	54934	54336	53855	53486
36	100770	99382	97238	96549	96887

VS (knots)	FL#2 0deg PE Ratio	FL#2 5deg PE Ratio	FL#2 10deg PE Ratio	FL#2 15deg PE Ratio
18	0.978	0.989	0.998	1.007
24	0.994	0.975	0.986	0.989
30	0.989	0.978	0.970	0.963
36	0.986	0.965	0.958	0.961

VS (knots)	FL#2 0deg PE Effect	FL#2 5deg PE Effect	FL#2 10deg PE Effect	FL#2 15deg PE Effect
18	-2.16%	-1.08%	-0.23%	0.71%
24	-0.64%	-2.53%	-1.43%	-1.12%
30	-1.07%	-2.15%	-3.02%	-3.68%
36	-1.38%	-3.51%	-4.19%	-3.85%

VS (knots)	Exp33 BSS GB FA* DES No Flap PE (hP)	Exp38 BSS GB FA* DES Flap#3 (1.0% Chord, 0.8Max Span) 0 deg TED PE (hP)	5 deg TED PE (hP)	10 deg TED PE (hP)	15 deg TED PE (hP)
18	13046	12397	12504	12546	12859
24	29143	28358	28259	28415	28989
30	55530	54332	53484	53568	54030
36	100770	99277	97136	96825	97271

VS (knots)	FL#3 0deg PE Ratio	FL#3 5deg PE Ratio	FL#3 10deg PE Ratio	FL#3 15deg PE Ratio
18	0.950	0.958	0.962	0.986
24	0.973	0.970	0.975	0.995
30	0.978	0.963	0.965	0.973
36	0.985	0.964	0.961	0.965

VS (knots)	FL#3 0deg PE Effect	FL#3 5deg PE Effect	FL#3 10deg PE Effect	FL#3 15deg PE Effect
18	-4.98%	-4.15%	-3.84%	-1.44%
24	-2.69%	-3.03%	-2.50%	-0.53%
30	-2.16%	-3.69%	-3.53%	-2.70%
36	-1.48%	-3.61%	-3.92%	-3.47%

VS (knots)	Exp33 BSS GB FA* DES No Flap PE (hP)	Exp36 BSS GB FA* DES Flap#1 (1.0% Chord, Max Span) 0 deg TED PE (hP)	5 deg TED PE (hP)	10 deg TED PE (hP)	15 deg TED PE (hP)
18	13046	12788	12936	12992	13239
24	29143	28804	28599	28620	29043
30	55530	55025	53528	53479	54193
36	100770	99817	97303	96706	98133

VS (knots)	FL#1 0deg PE Ratio	FL#1 5deg PE Ratio	FL#1 10deg PE Ratio	FL#1 15deg PE Ratio
18	0.980	0.992	0.996	1.015
24	0.988	0.981	0.982	0.997
30	0.991	0.964	0.963	0.976
36	0.991	0.966	0.960	0.974

VS (knots)	FL#1 0deg PE Effect	FL#1 5deg PE Effect	FL#1 10deg PE Effect	FL#1 15deg PE Effect
18	-1.98%	-0.85%	-0.42%	1.47%
24	-1.16%	-1.87%	-1.80%	-0.35%
30	-0.91%	-3.61%	-3.69%	-2.41%
36	-0.95%	-3.44%	-4.03%	-2.62%

VS (knots)	Exp33 BSS GB FA* DES No Flap PE (hP)	Exp39 BSS GB FA* DES Flap#4 (1.35% Chord, 0.8Max Span) 0 deg TED PE (hP)	5 deg TED PE (hP)	10 deg TED PE (hP)	15 deg TED PE (hP)
18	13046	12375	12438	12668	12965
24	29143	28361	28318	28836	28820
30	55530	54189	53584	53327	54076
36	100770	98000	96187	96003	96947

VS (knots)	FL#4 0deg PE Ratio	FL#4 5deg PE Ratio	FL#4 10deg PE Ratio	FL#4 15deg PE Ratio
18	0.949	0.953	0.971	0.994
24	0.973	0.972	0.989	0.989
30	0.976	0.965	0.960	0.974
36	0.973	0.955	0.953	0.962

VS (knots)	FL#4 0deg PE Effect	FL#4 5deg PE Effect	FL#4 10deg PE Effect	FL#4 15deg PE Effect
18	-5.15%	-4.66%	-2.90%	-0.63%
24	-2.68%	-2.83%	-1.05%	-1.11%
30	-2.42%	-3.51%	-3.97%	-2.62%
36	-2.75%	-4.55%	-4.73%	-3.79%

Table B8. JHSS BSS GB FA DES, Flap#4 @10°, Exp40, effective power prediction

JHSS Exp40 BSS GB FA* DES Flap#4@10deg (PE from CR input)

	SHIP		MODEL	
LAMBDA			34.121	
LWL	977.9	ft	28.660	ft
S	106845	ft^2	91.772	ft^2
WT	36491	LT	2000.6	lbs
RHO	1.9905	$(lbf*sec^2)/ft^4$	1.9365	$(lbf*sec^2)/ft^4$
NU	1.2817E-05	ft^2/sec	1.0692E-05	ft^2/sec
Ca			0.0000	

Vs	PE		FRICTIONAL POWER		FN	V-L	1000CR
knots	HP	KW	HP	KW			
15.0	7867.9	5867.1	4432.5	3305.3	0.143	0.480	1.095
16.0	9333.9	6960.3	5338.3	3980.8	0.152	0.512	1.049
17.0	10962.2	8174.5	6357.3	4740.6	0.162	0.544	1.008
18.0	12758.9	9514.3	7495.6	5589.5	0.171	0.576	0.971
19.0	14709.5	10968.9	8759.6	6532.1	0.181	0.608	0.933
20.0	16867.5	12578.1	10155.5	7572.9	0.190	0.640	0.903
21.0	19297.8	14390.3	11689.3	8716.7	0.200	0.672	0.884
22.0	22025.2	16424.2	13367.2	9967.9	0.209	0.704	0.875
23.0	25058.0	18685.7	15195.3	11331.1	0.219	0.735	0.872
24.0	28386.7	21167.9	17179.6	12810.8	0.228	0.767	0.872
25.0	31986.6	23852.4	19326.2	14411.5	0.238	0.799	0.872
26.0	35824.1	26714.0	21641.0	16137.7	0.247	0.831	0.868
27.0	39865.4	29727.7	24130.1	17993.8	0.257	0.863	0.860
28.0	44090.1	32878.0	26799.4	19984.3	0.266	0.895	0.847
29.0	48504.6	36169.9	29654.8	22113.6	0.276	0.927	0.831
30.0	53157.1	39639.2	32702.2	24386.0	0.285	0.959	0.815
31.0	58150.8	43363.1	35947.6	26806.1	0.295	0.991	0.802
32.0	63653.7	47466.6	39396.8	29378.2	0.304	1.023	0.796
33.0	69902.1	52126.0	43055.6	32106.5	0.314	1.055	0.804
34.0	77196.6	57565.5	46929.9	34995.6	0.324	1.087	0.828
35.0	85887.9	64046.6	51025.4	38049.7	0.333	1.119	0.875
36.0	96351.3	71849.2	55348.1	41273.1	0.343	1.151	0.945
37.0	108950.4	81244.3	59903.7	44670.2	0.352	1.183	1.042
38.0	123990.2	92459.5	64697.8	48245.2	0.362	1.215	1.162
39.0	141662.7	105637.9	69736.4	52002.4	0.371	1.247	1.304
40.0	161993.2	120798.3	75025.1	55946.2	0.381	1.279	1.462
41.0	184792.3	137799.6	80569.6	60080.7	0.390	1.311	1.627
42.0	209631.4	156322.1	86375.6	64410.3	0.400	1.343	1.790
43.0	235856.2	175877.9	92448.8	68939.1	0.409	1.375	1.940
44.0	262665.0	195869.3	98795.0	73671.4	0.419	1.407	2.069
45.0	289281.5	215717.2	105419.7	78611.4	0.428	1.439	2.171

Table B9. JHSS BSS GB FA HVY, Flap#4 @10°, Exp43, effective power prediction

JHSS Exp43 BSS GB FA* HVY Flap#4@10deg (PE from CR input)

	SHIP		MODEL	
LAMBDA			34.121	
LWL	947.9	ft	27.781	ft
S	110463.5	ft^2	94.880	ft^2
WT	40140	LT	2200.7	lbs
RHO	1.9905	$(lbf*sec^2)/ft^4$	1.9365	$(lbf*sec^2)/ft^4$
NU	1.2817E-05	ft^2/sec	1.0692E-05	ft^2/sec
Ca			0.0000	

Vs	PE		FRICTIONAL POWER		FN	V-L	1000CR
knots	HP	KW	HP	KW			
15.0	8271.1	6167.8	4599.7	3430.0	0.145	0.487	1.132
16.0	9872.1	7361.6	5539.6	4130.9	0.155	0.520	1.101
17.0	11675.4	8706.4	6596.9	4919.3	0.164	0.552	1.076
18.0	13651.8	10180.1	7778.0	5800.1	0.174	0.585	1.048
19.0	15794.3	11777.8	9089.6	6778.1	0.184	0.617	1.017
20.0	18119.3	13511.6	10537.9	7858.1	0.193	0.650	0.986
21.0	20661.1	15407.0	12129.3	9044.8	0.203	0.682	0.959
22.0	23462.0	17495.6	13870.2	10343.0	0.213	0.715	0.937
23.0	26561.0	19806.5	15767.0	11757.4	0.222	0.747	0.923
24.0	29982.5	22357.9	17825.8	13292.7	0.232	0.780	0.915
25.0	33729.1	25151.8	20052.9	14953.5	0.242	0.812	0.911
26.0	37779.9	28172.5	22454.6	16744.4	0.251	0.844	0.907
27.0	42095.9	31390.9	25037.1	18670.2	0.261	0.877	0.902
28.0	46633.9	34774.9	27806.5	20735.3	0.271	0.909	0.892
29.0	51367.3	38304.6	30769.0	22944.4	0.280	0.942	0.879
30.0	56311.7	41991.6	33930.7	25302.1	0.290	0.974	0.863
31.0	61552.2	45899.5	37297.7	27812.9	0.300	1.007	0.847
32.0	67267.3	50161.2	40876.1	30481.3	0.309	1.039	0.838
33.0	73742.7	54989.9	44672.1	33312.0	0.319	1.072	0.842
34.0	81371.2	60678.5	48691.5	36309.3	0.329	1.104	0.865
35.0	90631.3	67583.7	52940.5	39477.8	0.338	1.137	0.915
36.0	102040.8	76091.8	57425.1	42821.9	0.348	1.169	0.995
37.0	116087.5	86566.5	62151.3	46346.2	0.358	1.202	1.108
38.0	133137.6	99280.7	67125.0	50055.1	0.367	1.234	1.252
39.0	153336.7	114343.2	72352.2	53953.0	0.377	1.267	1.421
40.0	176522.8	131633.0	77838.8	58044.4	0.387	1.299	1.604
41.0	202186.1	150770.2	83590.9	62333.7	0.396	1.332	1.790
42.0	229526.2	171157.7	89614.2	66825.3	0.406	1.364	1.965
43.0	257675.0	192148.2	95914.7	71523.6	0.416	1.397	2.117
44.0	286182.8	213406.5	102498.3	76433.0	0.425	1.429	2.244
45.0	315890.2	235559.3	109370.9	81557.8	0.435	1.462	2.358

Table B10. JHSS BSS GB FA DES, +5ft Trim (bow up), Exp46, effective power prediction

JHSS Exp46 BSS GB FA* DES +5ftTrim (PE from CR input)

	SHIP		MODEL	
LAMBDA			34.121	
LWL	982.03	ft	28.781	ft
S	105902	ft^2	90.962	ft^2
WT	36491	LT	2000.6	lbs
RHO	1.9905	$(lbf*sec^2)/ft^4$	1.9365	$(lbf*sec^2)/ft^4$
NU	1.2817E-05	ft^2/sec	1.0692E-05	ft^2/sec
Ca			0.0000	

Vs	PE		FRICTIONAL POWER		FN	V-L	1000CR
knots	HP	KW	HP	KW			
15.0	9132.4	6810.1	4391.2	3274.5	0.142	0.479	1.525
16.0	10840.3	8083.6	5288.6	3943.7	0.152	0.511	1.471
17.0	12732.9	9494.9	6298.0	4696.4	0.161	0.542	1.422
18.0	14814.4	11047.1	7425.8	5537.4	0.171	0.574	1.375
19.0	17101.3	12752.5	8678.0	6471.2	0.180	0.606	1.333
20.0	19619.9	14630.5	10060.9	7502.4	0.190	0.638	1.297
21.0	22399.8	16703.5	11580.4	8635.5	0.199	0.670	1.268
22.0	25467.7	18991.3	13242.7	9875.1	0.209	0.702	1.246
23.0	28839.9	21505.9	15053.8	11225.6	0.218	0.734	1.230
24.0	32517.3	24248.2	17019.7	12691.6	0.228	0.766	1.217
25.0	36484.4	27206.4	19146.3	14277.4	0.237	0.798	1.204
26.0	40711.6	30358.6	21439.6	15987.5	0.247	0.830	1.190
27.0	45164.2	33678.9	23905.5	17826.3	0.256	0.862	1.172
28.0	49815.2	37147.2	26550.0	19798.3	0.266	0.894	1.150
29.0	54662.5	40761.8	29378.8	21907.8	0.275	0.925	1.125
30.0	59747.7	44553.9	32398.0	24159.2	0.285	0.957	1.099
31.0	65173.8	48600.1	35613.2	26556.7	0.294	0.989	1.077
32.0	71118.2	53032.9	39030.3	29104.9	0.304	1.021	1.063
33.0	77837.6	58043.5	42655.1	31807.9	0.313	1.053	1.063
34.0	85660.1	63876.8	46493.4	34670.1	0.323	1.085	1.082
35.0	94962.9	70813.8	50550.9	37695.8	0.332	1.117	1.124
36.0	106132.6	79143.0	54833.4	40889.3	0.342	1.149	1.193
37.0	119511.7	89119.9	59346.7	44254.8	0.351	1.181	1.289
38.0	135334.4	100918.9	64096.3	47796.6	0.361	1.213	1.409
39.0	153663.8	114587.1	69088.1	51519.0	0.370	1.245	1.547
40.0	174348.1	130011.3	74327.6	55426.1	0.380	1.276	1.696
41.0	197023.1	146920.1	79820.6	59522.2	0.389	1.308	1.846
42.0	221200.5	164949.2	85572.7	63811.6	0.399	1.340	1.987
43.0	246493.9	183810.5	91589.6	68298.3	0.408	1.372	2.115
44.0	273055.1	203617.2	97876.8	72986.7	0.418	1.404	2.232
45.0	302309.6	225432.3	104440.0	77880.9	0.427	1.436	2.357

Table B11. JHSS BSS GB FA DES, -5ft Trim (bow down), Exp47, effective power prediction

JHSS Exp47 BSS GB FA* DES -5ftTrim (PE from CR input)

	SHIP		MODEL	
LAMBDA			34.121	
LWL	942.4	ft	27.619	ft
S	104628	ft^2	89.868	ft^2
WT	36491	LT	2000.6	lbs
RHO	1.9905	$(lbf*sec^2)/ft^4$	1.9365	$(lbf*sec^2)/ft^4$
NU	1.2817E-05	ft^2/sec	1.0692E-05	ft^2/sec
Ca			0.0000	

Vs	PE		FRICTIONAL POWER		FN	V-L	1000CR
knots	HP	KW	HP	KW			
15.0	7224.3	5387.2	4359.8	3251.1	0.145	0.489	0.932
16.0	8684.0	6475.6	5250.6	3915.4	0.155	0.521	0.921
17.0	10363.7	7728.2	6252.7	4662.6	0.165	0.554	0.919
18.0	12233.3	9122.3	7372.2	5497.5	0.174	0.586	0.916
19.0	14283.0	10650.9	8615.3	6424.4	0.184	0.619	0.908
20.0	16525.6	12323.1	9988.0	7448.1	0.194	0.651	0.898
21.0	18991.7	14162.1	11496.4	8572.9	0.204	0.684	0.889
22.0	21722.3	16198.3	13146.4	9803.3	0.213	0.717	0.885
23.0	24757.5	18461.6	14944.2	11143.9	0.223	0.749	0.886
24.0	28126.3	20973.8	16895.5	12599.0	0.233	0.782	0.892
25.0	31838.6	23742.1	19006.4	14173.1	0.242	0.814	0.902
26.0	35882.6	26757.7	21282.7	15870.5	0.252	0.847	0.913
27.0	40228.4	29998.3	23730.4	17695.7	0.262	0.880	0.921
28.0	44839.0	33436.4	26355.2	19653.1	0.271	0.912	0.925
29.0	49688.6	37052.8	29163.0	21746.9	0.281	0.945	0.925
30.0	54785.4	40853.5	32159.7	23981.5	0.291	0.977	0.921
31.0	60196.3	44888.4	35350.9	26361.2	0.300	1.010	0.916
32.0	66069.6	49268.1	38742.5	28890.3	0.310	1.042	0.916
33.0	72650.0	54175.1	42340.3	31573.1	0.320	1.075	0.927
34.0	80279.9	59864.8	46149.9	34413.9	0.330	1.108	0.954
35.0	89384.0	66653.6	50177.0	37417.0	0.339	1.140	1.005
36.0	100430.0	74890.7	54427.5	40586.6	0.349	1.173	1.083
37.0	113868.4	84911.7	58906.8	43926.8	0.359	1.205	1.192
38.0	130051.3	96979.3	63620.8	47442.1	0.368	1.238	1.330
39.0	149142.7	111215.7	68575.1	51136.4	0.378	1.270	1.492
40.0	171035.6	127541.2	73775.2	55014.2	0.388	1.303	1.669
41.0	195309.0	145641.9	79226.9	59079.5	0.397	1.336	1.850
42.0	221265.1	164997.4	84935.7	63336.6	0.407	1.368	2.021
43.0	248111.7	185016.9	90907.2	67789.5	0.417	1.401	2.172
44.0	275372.1	205345.0	97147.0	72442.5	0.426	1.433	2.298
45.0	303633.8	226419.7	103660.7	77299.8	0.436	1.466	2.411

Table B12. JHSS BSS GB FA, effective power predictions, summary and comparisons

VS	Pre-Test Estimate	Exp33 BSS GB FA* DES Ser3	Exp33/ Pre-Test	Exp40 BSS GB FA* DES Flap#4@10°	Exp40/ Exp33	Exp43 BSS GB FA* HVY Flap#4@10°	Exp43/ Exp40	Exp46 BSS GB FA* DES +5ftTrim	Exp46/ Exp33	Exp47 BSS GB FA* DES -5ftTrim	Exp47/ Exp33
(knots)	PE (hP)	PE (hP)	PE ratio	PE (hP)	PE ratio	PE (hP)	PE ratio	PE (hP)	PE ratio	PE (hP)	PE ratio
14		6397		6569	1.027	6917	1.053	7617	1.191	5922	0.926
15		7821		7868	1.006	8271	1.051	9132	1.168	7224	0.924
16	10332	9413	0.911	9334	0.992	9872	1.058	10840	1.152	8684	0.923
17		11157		10962	0.983	11675	1.065	12733	1.141	10364	0.929
18	14636	13050	0.892	12759	0.978	13652	1.070	14814	1.135	12233	0.937
19		15111		14709	0.973	15794	1.074	17101	1.132	14283	0.945
20	20153	17370	0.862	16868	0.971	18119	1.074	19620	1.130	16526	0.951
21		19868		19298	0.971	20661	1.071	22400	1.127	18992	0.956
22	26865	22645	0.843	22025	0.973	23462	1.065	25468	1.125	21722	0.959
23		25733		25058	0.974	26561	1.060	28840	1.121	24757	0.962
24	34539	29147	0.844	28387	0.974	29982	1.056	32517	1.116	28126	0.965
25		32884		31987	0.973	33729	1.054	36484	1.109	31839	0.968
26	43518	36921	0.848	35824	0.970	37780	1.055	40712	1.103	35883	0.972
27		41223		39865	0.967	42096	1.056	45164	1.096	40228	0.976
28	53940	45758	0.848	44090	0.964	46634	1.058	49815	1.089	44839	0.980
29		50511		48505	0.960	51367	1.059	54663	1.082	49689	0.984
30	65368	55505	0.849	53157	0.958	56312	1.059	59748	1.076	54785	0.987
31		60825		58151	0.956	61552	1.058	65174	1.071	60196	0.990
32	77025	66631	0.865	63654	0.955	67267	1.057	71118	1.067	66070	0.992
33		73167		69902	0.955	73743	1.055	77838	1.064	72650	0.993
34	90502	80763	0.892	77197	0.956	81371	1.054	85660	1.061	80280	0.994
35	99446	89809	0.903	85888	0.956	90631	1.055	94963	1.057	89384	0.995
36	110476	100723	0.912	96351	0.957	102041	1.059	106133	1.054	100430	0.997
37	123934	113898	0.919	108950	0.957	116088	1.066	119512	1.049	113868	1.000
38	140135	129630	0.925	123990	0.956	133138	1.074	135334	1.044	130051	1.003
39	159226	148049	0.930	141663	0.957	153337	1.082	153664	1.038	149143	1.007
40	181253	169060	0.933	161993	0.958	176523	1.090	174348	1.031	171036	1.012
41	206097	192319	0.933	184792	0.961	202186	1.094	197023	1.024	195309	1.016
42	233272	217294	0.932	209631	0.965	229526	1.095	221200	1.018	221265	1.018
43	261896	243439	0.930	235856	0.969	257675	1.093	246494	1.013	248112	1.019
44	291039	270583	0.930	262665	0.971	286183	1.090	273055	1.009	275372	1.018
45		299588		289282	0.966	315890	1.092	302310	1.009	303634	1.014

Table B13a. JHSS BSS GB FA DES, Exp34, stock propeller powering prediction

JHSS BSS GB DES Exp34 Stock Props

LENGTH (LWL) 977.9 FT (298.1 M)
DISPLACEMENT 36490.5 TONS (37074.2 TONNES)
WETTED SURFACE 106845.0 SQ FT (9926.2 SQ M)
INBOARD PROP DIA 21.33 FT (6.50 M)
OUTBOARD PROP DIA 21.33 FT (6.50 M)
ITTC FRICTION USED CORRELATION ALLOWANCE 0.00000

TOTAL (ALL FOUR SHAFTS COMBINED)

SHIP SPEED		EFFECTIVE POWER		DELIVERED POWER		PROPELLER	ETAD	ETAO+	ETAB+	1-t	CTS	CFS	CR
(KNOTS)	(M/SEC)	(HP)	(KW)	(HP)	(KW)	RPM							
15	7.72	7821	5832	11503	8578	55.0	0.680	0.700	0.728	0.935	2.493	1.413	1.080
16	8.23	9413	7019	13912	10374	58.2	0.677	0.700	0.716	0.941	2.472	1.402	1.070
17	8.75	11157	8320	16594	12374	61.6	0.672	0.699	0.707	0.946	2.443	1.392	1.051
18	9.26	13050	9731	19529	14563	65.1	0.668	0.698	0.700	0.949	2.407	1.383	1.025
19	9.77	15111	11268	22755	16968	68.7	0.664	0.696	0.696	0.950	2.370	1.374	0.996
20	10.29	17370	12953	26332	19636	72.3	0.660	0.694	0.694	0.949	2.336	1.366	0.970
21	10.80	19868	14816	30341	22626	75.9	0.655	0.692	0.692	0.946	2.308	1.358	0.950
22	11.32	22645	16886	34775	25932	79.4	0.651	0.692	0.690	0.942	2.288	1.350	0.937
23	11.83	25733	19189	39777	29662	83.1	0.647	0.691	0.689	0.937	2.275	1.344	0.932
24	12.35	29147	21735	45295	33776	86.6	0.643	0.692	0.690	0.929	2.268	1.337	0.931
25	12.86	32884	24522	51376	38311	90.1	0.640	0.693	0.690	0.922	2.264	1.331	0.933
26	13.38	36921	27532	57958	43219	93.6	0.637	0.694	0.690	0.914	2.260	1.325	0.935
27	13.89	41223	30740	64937	48424	97.1	0.635	0.695	0.692	0.906	2.253	1.319	0.934
28	14.40	45758	34122	72334	53940	100.6	0.633	0.696	0.694	0.898	2.242	1.313	0.929
29	14.92	50511	37666	80078	59714	104.0	0.631	0.697	0.696	0.892	2.228	1.308	0.920
30	15.43	55505	41390	88166	65746	107.4	0.630	0.698	0.699	0.885	2.211	1.303	0.909
31	15.95	60825	45357	96650	72072	110.8	0.629	0.698	0.702	0.881	2.196	1.298	0.898
32	16.46	66631	49687	105914	78980	114.3	0.629	0.699	0.704	0.877	2.187	1.293	0.894
33	16.98	73167	54561	116236	86677	117.9	0.629	0.699	0.706	0.875	2.190	1.289	0.901
34	17.49	80763	60225	128147	95559	121.5	0.630	0.701	0.707	0.875	2.210	1.284	0.926
35	18.01	89809	66971	142234	106064	125.2	0.631	0.703	0.707	0.876	2.253	1.280	0.973
36	18.52	100723	75109	159076	118623	129.2	0.633	0.705	0.706	0.878	2.322	1.276	1.046
37	19.03	113898	84934	179267	133680	133.3	0.635	0.709	0.704	0.883	2.419	1.272	1.147
38	19.55	129630	96665	203333	151626	137.7	0.638	0.712	0.703	0.888	2.541	1.268	1.273
39	20.06	148049	110400	231284	172468	142.5	0.640	0.715	0.702	0.894	2.685	1.265	1.420
40	20.58	169060	126068	263042	196151	147.5	0.643	0.717	0.701	0.900	2.842	1.261	1.581
41	21.09	192319	143412	297833	222094	152.7	0.646	0.719	0.703	0.906	3.002	1.258	1.744
42	21.61	217294	162036	335387	250098	158.2	0.648	0.720	0.706	0.910	3.155	1.254	1.901
43	22.12	243439	181532	374742	279445	163.5	0.650	0.721	0.709	0.912	3.294	1.251	2.043
44	22.64	270583	201774	415427	309784	168.2	0.651	0.722	0.712	0.908	3.417	1.248	2.169

+ETAO and ETAB (TOTAL) = AVERAGE OF INBOARD AND OUTBOARD VALUES

Table B13a. JHSS BSS GB FA DES, Exp34, stock propeller powering prediction (continued)

JHSS BSS GB DES Exp34 Stock Props													
INBOARD (PER SHAFT)													
SPEED (KNOTS)	DELIVERED (HP)	POWER (KW)	THRUST (LBS)	(X1000) (KG)	TORQUE (FT-LB)	(X1000) (KG-M)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER RPM
15	3069	2289	51.80	23.50	293.30	40.57	0.709	0.763	1.076	0.982	1.004	1.273	55.0
16	3741	2790	57.60	26.13	337.50	46.68	0.708	0.739	1.043	0.977	0.990	1.275	58.2
17	4492	3349	63.70	28.91	382.80	52.94	0.707	0.723	1.022	0.976	0.983	1.279	61.6
18	5314	3962	70.20	31.86	428.70	59.29	0.706	0.713	1.010	0.977	0.980	1.282	65.1
19	6224	4641	77.10	34.99	476.00	65.84	0.705	0.707	1.003	0.978	0.979	1.286	68.7
20	7225	5388	84.70	38.44	525.00	72.61	0.704	0.705	1.002	0.980	0.981	1.288	72.3
21	8348	6225	93.00	42.17	577.70	79.90	0.703	0.704	1.001	0.981	0.981	1.289	75.9
22	9579	7143	102.00	46.27	633.30	87.58	0.703	0.705	1.002	0.980	0.980	1.289	79.4
23	10978	8186	112.00	50.79	694.20	96.01	0.704	0.705	1.001	0.979	0.980	1.288	83.1
24	12499	9320	122.90	55.75	758.00	104.83	0.705	0.707	1.003	0.977	0.978	1.285	86.6
25	14174	10570	134.50	60.99	825.90	114.22	0.706	0.709	1.004	0.974	0.975	1.283	90.1
26	15997	11929	146.40	66.42	897.60	124.14	0.707	0.709	1.003	0.970	0.971	1.280	93.6
27	17892	13342	158.70	71.96	967.50	133.81	0.707	0.711	1.006	0.968	0.970	1.278	97.1
28	19895	14836	170.90	77.52	1038.90	143.68	0.708	0.713	1.007	0.966	0.968	1.277	100.6
29	22000	16405	182.90	82.94	1110.90	153.64	0.708	0.713	1.008	0.964	0.967	1.277	104.0
30	24175	18027	194.70	88.33	1181.80	163.44	0.708	0.714	1.010	0.963	0.966	1.277	107.4
31	26446	19721	206.50	93.68	1253.00	173.29	0.707	0.715	1.011	0.963	0.966	1.278	110.8
32	28920	21565	218.60	99.16	1328.40	183.72	0.707	0.715	1.011	0.963	0.966	1.280	114.3
33	31647	23599	231.60	105.04	1409.60	194.95	0.706	0.714	1.011	0.964	0.967	1.281	117.9
34	34812	25959	246.50	111.82	1505.00	208.14	0.707	0.712	1.007	0.963	0.965	1.280	121.5
35	38578	28767	264.30	119.88	1617.70	223.73	0.708	0.709	1.001	0.963	0.963	1.278	125.2
36	43044	32098	285.60	129.56	1749.60	241.97	0.709	0.706	0.996	0.963	0.961	1.274	129.2
37	48426	36111	311.10	141.13	1907.90	263.86	0.711	0.701	0.987	0.962	0.957	1.267	133.3
38	54835	40890	341.40	154.86	2090.80	289.16	0.713	0.698	0.979	0.961	0.954	1.259	137.7
39	62310	46465	376.70	170.86	2297.20	317.70	0.715	0.696	0.973	0.962	0.952	1.250	142.5
40	70796	52792	415.80	188.63	2521.30	348.70	0.717	0.695	0.969	0.964	0.952	1.241	147.5
41	80133	59755	458.70	208.09	2756.10	381.17	0.718	0.696	0.969	0.966	0.954	1.232	152.7
42	90089	67179	504.20	228.69	2991.60	413.74	0.719	0.700	0.974	0.971	0.960	1.224	158.2
43	100441	74890	551.70	250.25	3226.40	446.21	0.720	0.706	0.981	0.974	0.966	1.216	163.5
44	111059	82830	602.90	273.46	3467.80	479.60	0.720	0.711	0.987	0.970	0.965	1.205	168.2

Table B13a. JHSS BSS GB FA DES, Exp34, stock propeller powering prediction (continued)

JHSS BSS GB DES Exp34 Stock Props													
OUTBOARD (PER SHAFT)													
SPEED	DELIVERED	POWER	THRUST	(X1000)	TORQUE	(X1000)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER
(KNOTS)	(HP)	(KW)	(LBS)	(KG)	(FT-LB)	(KG-M)							RPM
15	2682	2000	39.00	17.71	256.30	35.45	0.691	0.693	1.002	1.034	1.034	1.340	55.0
16	3215	2397	44.20	20.06	290.00	40.11	0.692	0.692	1.000	1.025	1.025	1.338	58.2
17	3805	2838	49.30	22.35	324.30	44.85	0.692	0.691	0.998	1.022	1.022	1.339	61.6
18	4451	3319	54.20	24.60	359.10	49.66	0.690	0.688	0.997	1.022	1.021	1.342	65.1
19	5154	3843	59.20	26.86	394.20	54.52	0.687	0.686	0.999	1.024	1.024	1.345	68.7
20	5940	4430	64.40	29.20	431.70	59.70	0.684	0.683	0.999	1.026	1.026	1.349	72.3
21	6823	5088	69.90	31.73	472.20	65.30	0.681	0.679	0.997	1.028	1.028	1.351	75.9
22	7809	5823	76.00	34.45	516.20	71.39	0.680	0.676	0.994	1.029	1.028	1.353	79.4
23	8910	6644	82.60	37.48	563.40	77.93	0.679	0.674	0.993	1.030	1.028	1.354	83.1
24	10149	7568	90.00	40.84	615.50	85.12	0.679	0.672	0.989	1.028	1.026	1.353	86.6
25	11514	8586	98.00	44.47	670.90	92.78	0.680	0.671	0.986	1.027	1.024	1.353	90.1
26	12982	9681	106.70	48.41	728.40	100.74	0.682	0.672	0.985	1.024	1.021	1.351	93.6
27	14577	10870	115.80	52.53	788.20	109.01	0.683	0.673	0.985	1.022	1.019	1.349	97.1
28	16272	12134	125.50	56.92	849.70	117.51	0.685	0.675	0.986	1.019	1.016	1.348	100.6
29	18040	13452	135.40	61.42	910.90	125.98	0.686	0.679	0.990	1.017	1.014	1.346	104.0
30	19909	14846	145.80	66.12	973.30	134.61	0.688	0.683	0.994	1.014	1.012	1.344	107.4
31	21879	16316	156.60	71.01	1036.70	143.38	0.689	0.688	0.999	1.011	1.011	1.343	110.8
32	24037	17925	168.30	76.33	1104.10	152.70	0.690	0.694	1.004	1.009	1.010	1.341	114.3
33	26471	19740	181.20	82.18	1179.10	163.07	0.692	0.698	1.008	1.007	1.009	1.338	117.9
34	29262	21821	195.90	88.84	1265.10	174.96	0.695	0.701	1.009	1.004	1.006	1.335	121.5
35	32539	24265	213.10	96.66	1364.50	188.71	0.698	0.705	1.010	1.002	1.005	1.330	125.2
36	36494	27213	233.30	105.82	1483.30	205.14	0.702	0.707	1.007	1.001	1.003	1.324	129.2
37	41208	30729	256.90	116.55	1623.50	224.53	0.706	0.707	1.002	0.999	1.000	1.317	133.3
38	46832	34922	284.50	129.03	1785.60	246.95	0.710	0.708	0.996	0.999	0.998	1.309	137.7
39	53332	39770	315.20	143.00	1966.20	271.93	0.714	0.708	0.991	1.000	0.998	1.300	142.5
40	60726	45283	349.20	158.40	2162.70	299.10	0.717	0.708	0.987	1.003	1.000	1.292	147.5
41	68784	51292	385.20	174.74	2365.80	327.19	0.720	0.710	0.987	1.008	1.004	1.285	152.7
42	77605	57870	422.30	191.57	2577.00	356.40	0.721	0.711	0.987	1.014	1.010	1.279	158.2
43	86942	64833	460.30	208.79	2793.10	386.29	0.723	0.712	0.986	1.020	1.015	1.274	163.5
44	96637	72062	500.50	227.02	3017.00	417.25	0.724	0.713	0.985	1.020	1.014	1.266	168.2

Table B13b. JHSS BSS GB FA DES, stock propeller powering prediction, SAD included

JHSS BSS GB DES Exp34 Stock Props w/SAD

LENGTH (LWL)	977.9 FT (298.1 M)
DISPLACEMENT	36490.5 TONS (37074.2 TONNES)
WETTED SURFACE	106845.0 SQ FT (9926.2 SQ M)
INBOARD PROP DIA	21.33 FT (6.50 M)
OUTBOARD PROP DIA	21.33 FT (6.50 M)
ITTC FRICTION USED	CORRELATION ALLOWANCE 0.00000

TOTAL (ALL FOUR SHAFTS COMBINED)

SHIP SPEED		EFFECTIVE POWER		DELIVERED POWER		PROPELLER	ETAD	ETAO+	ETAB+	1-t	CTS	CFS	CR
(KNOTS)	(M/SEC)	(HP)	(KW)	(HP)	(KW)	RPM							
15	7.72	8038	5994	11582	8637	55.0	0.694	0.701	0.728	0.954	2.562	1.413	1.149
16	8.23	9676	7215	14033	10464	58.3	0.690	0.701	0.716	0.958	2.541	1.402	1.139
17	8.75	11472	8555	16759	12497	61.7	0.685	0.700	0.707	0.962	2.512	1.392	1.120
18	9.26	13425	10011	19743	14722	65.2	0.680	0.699	0.701	0.965	2.476	1.383	1.094
19	9.77	15551	11596	22984	17139	68.8	0.677	0.697	0.697	0.967	2.439	1.374	1.065
20	10.29	17884	13336	26566	19811	72.4	0.673	0.695	0.695	0.967	2.405	1.366	1.039
21	10.80	20463	15259	30578	22802	76.0	0.669	0.693	0.692	0.966	2.377	1.358	1.019
22	11.32	23329	17396	35024	26117	79.5	0.666	0.692	0.691	0.963	2.357	1.350	1.006
23	11.83	26514	19771	40018	29841	83.1	0.663	0.692	0.690	0.959	2.344	1.344	1.001
24	12.35	30035	22397	45551	33967	86.7	0.659	0.693	0.690	0.952	2.337	1.337	1.000
25	12.86	33887	25270	51639	38507	90.2	0.656	0.693	0.690	0.945	2.333	1.331	1.002
26	13.38	38050	28374	58217	43413	93.7	0.654	0.695	0.691	0.937	2.329	1.325	1.004
27	13.89	42487	31683	65240	48649	97.2	0.651	0.696	0.693	0.929	2.322	1.319	1.003
28	14.40	47168	35173	72782	54273	100.7	0.648	0.697	0.694	0.920	2.311	1.313	0.998
29	14.92	52077	38834	80637	60131	104.1	0.646	0.697	0.697	0.912	2.297	1.308	0.989
30	15.43	57239	42683	88914	66303	107.6	0.644	0.698	0.700	0.904	2.281	1.303	0.978
31	15.95	62738	46784	97652	72819	111.0	0.642	0.699	0.703	0.898	2.265	1.298	0.967
32	16.46	68735	51256	107292	80008	114.6	0.641	0.700	0.705	0.892	2.257	1.293	0.963
33	16.98	75475	56282	117860	87888	118.2	0.640	0.701	0.707	0.889	2.259	1.289	0.970
34	17.49	83287	62107	130066	96990	121.7	0.640	0.702	0.708	0.887	2.280	1.284	0.995
35	18.01	92562	69023	144597	107826	125.5	0.640	0.704	0.708	0.886	2.322	1.280	1.042
36	18.52	103719	77343	161728	120601	129.6	0.641	0.707	0.708	0.888	2.391	1.276	1.115
37	19.03	117151	87359	182349	135978	133.7	0.642	0.710	0.706	0.891	2.488	1.272	1.216
38	19.55	133154	99293	206639	154090	138.1	0.644	0.713	0.704	0.896	2.610	1.268	1.342
39	20.06	151858	113240	235042	175271	142.8	0.646	0.716	0.703	0.901	2.754	1.265	1.489
40	20.58	173170	129133	267206	199256	147.9	0.648	0.718	0.702	0.907	2.911	1.261	1.650
41	21.09	196745	146713	301934	225152	153.0	0.652	0.720	0.704	0.913	3.071	1.258	1.813
42	21.61	222052	165584	339657	253282	158.5	0.654	0.721	0.707	0.917	3.224	1.254	1.970
43	22.12	248545	185340	379271	282822	163.8	0.655	0.722	0.710	0.919	3.363	1.251	2.112
44	22.64	276053	205853	419945	313153	168.6	0.657	0.723	0.712	0.916	3.486	1.248	2.239

+ETAO and ETAB (TOTAL) = AVERAGE OF INBOARD AND OUTBOARD VALUES

Table B13b. JHSS BSS GB FA DES, stock propeller powering prediction, SAD included (continued)

JHSS BSS GB DES Exp34 Stock Props w/SAD													
INBOARD (PER SHAFT)													
SPEED	DELIVERED	POWER	THRUST	(X1000)	TORQUE	(X1000)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER
(KNOTS)	(HP)	(KW)	(LBS)	(KG)	(FT-LB)	(KG-M)							RPM
15	3090	2304	52.20	23.68	295.00	40.80	0.710	0.764	1.076	0.982	1.004	1.271	55.0
16	3771	2812	58.10	26.37	339.80	47.00	0.709	0.739	1.043	0.977	0.990	1.274	58.3
17	4531	3379	64.40	29.20	385.70	53.34	0.708	0.723	1.022	0.976	0.983	1.277	61.7
18	5362	3998	70.90	32.16	431.90	59.73	0.707	0.714	1.010	0.977	0.980	1.281	65.2
19	6288	4689	78.00	35.40	480.30	66.42	0.706	0.708	1.003	0.978	0.979	1.283	68.8
20	7280	5429	85.40	38.75	528.40	73.08	0.704	0.706	1.002	0.980	0.981	1.286	72.4
21	8398	6262	93.60	42.45	580.60	80.30	0.704	0.705	1.001	0.981	0.981	1.288	76.0
22	9640	7189	102.80	46.62	636.60	88.04	0.704	0.705	1.002	0.980	0.981	1.287	79.5
23	11055	8244	112.80	51.18	698.40	96.59	0.704	0.705	1.001	0.979	0.979	1.286	83.1
24	12543	9353	123.30	55.91	760.10	105.12	0.705	0.707	1.003	0.977	0.978	1.285	86.7
25	14235	10615	135.10	61.26	828.80	114.62	0.706	0.709	1.004	0.974	0.975	1.282	90.2
26	16063	11978	147.20	66.78	900.80	124.58	0.707	0.709	1.003	0.970	0.971	1.279	93.7
27	17964	13396	159.50	72.34	970.90	134.28	0.708	0.712	1.006	0.968	0.970	1.277	97.2
28	19993	14909	171.80	77.92	1043.30	144.29	0.708	0.713	1.007	0.966	0.968	1.276	100.7
29	22174	16535	184.60	83.74	1118.50	154.69	0.709	0.714	1.008	0.964	0.966	1.275	104.1
30	24380	18180	196.80	89.25	1190.40	164.63	0.708	0.716	1.010	0.963	0.966	1.275	107.6
31	26683	19897	208.50	94.56	1262.20	174.56	0.708	0.716	1.011	0.963	0.966	1.277	111.0
32	29273	21829	221.50	100.47	1342.10	185.61	0.708	0.716	1.011	0.963	0.966	1.277	114.6
33	32036	23889	234.70	106.45	1424.00	196.94	0.707	0.715	1.011	0.964	0.967	1.278	118.2
34	35280	26308	250.30	113.52	1522.10	210.51	0.708	0.713	1.007	0.963	0.965	1.277	121.7
35	39159	29201	268.50	121.81	1638.10	226.55	0.709	0.709	1.001	0.963	0.963	1.275	125.5
36	43689	32579	290.40	131.72	1771.10	244.94	0.710	0.707	0.996	0.963	0.962	1.271	129.6
37	49158	36657	316.20	143.42	1931.30	267.10	0.712	0.703	0.987	0.962	0.958	1.264	133.7
38	55706	41540	347.40	157.60	2118.80	293.03	0.714	0.699	0.979	0.961	0.954	1.256	138.1
39	63222	47144	382.40	173.47	2324.80	321.52	0.716	0.696	0.973	0.962	0.952	1.247	142.8
40	71790	53534	421.70	191.28	2550.20	352.69	0.717	0.695	0.969	0.964	0.952	1.238	147.9
41	81259	60595	465.50	211.17	2788.60	385.66	0.719	0.696	0.969	0.966	0.954	1.229	153.0
42	91111	67941	510.10	231.37	3019.10	417.54	0.719	0.701	0.974	0.971	0.960	1.222	158.5
43	101514	75718	558.00	253.10	3254.90	450.15	0.720	0.706	0.981	0.974	0.966	1.214	163.8
44	112380	83777	609.90	276.67	3500.70	484.15	0.720	0.711	0.987	0.970	0.964	1.202	168.6

Table B13b. JHSS BSS GB FA DES, stock propeller powering prediction, SAD included (continued)

JHSS BSS GB DES Exp34 Stock Props w/SAD													
OUTBOARD (PER SHAFT)													
SPEED (KNOTS)	DELIVERED (HP)	POWER (KW)	THRUST (X1000) (LBS)	THRUST (X1000) (KG)	TORQUE (X1000) (FT-LB)	TORQUE (X1000) (KG-M)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER RPM
15	2701	2014	39.30	17.83	257.90	35.66	0.691	0.693	1.002	1.034	1.034	1.339	55.0
16	3246	2420	44.70	20.29	292.50	40.45	0.693	0.693	1.000	1.025	1.025	1.336	58.3
17	3849	2870	49.90	22.64	327.60	45.30	0.693	0.691	0.998	1.022	1.022	1.337	61.7
18	4509	3363	55.00	24.96	363.20	50.23	0.691	0.689	0.997	1.022	1.021	1.340	65.2
19	5204	3881	59.90	27.16	397.50	54.98	0.688	0.687	0.999	1.024	1.024	1.344	68.8
20	6003	4477	65.20	29.59	435.70	60.26	0.685	0.684	0.999	1.026	1.026	1.347	72.4
21	6891	5139	70.80	32.10	476.40	65.89	0.682	0.680	0.997	1.028	1.027	1.349	76.0
22	7872	5870	76.60	34.76	519.80	71.89	0.680	0.676	0.994	1.029	1.028	1.352	79.5
23	8954	6677	83.00	37.67	565.70	78.23	0.679	0.674	0.993	1.030	1.029	1.353	83.1
24	10232	7630	90.90	41.24	620.10	85.76	0.680	0.673	0.989	1.028	1.026	1.352	86.7
25	11584	8638	98.60	44.75	674.50	93.28	0.680	0.671	0.986	1.027	1.024	1.352	90.2
26	13046	9728	107.30	48.65	731.60	101.18	0.682	0.672	0.985	1.024	1.021	1.350	93.7
27	14655	10929	116.50	52.84	792.10	109.55	0.683	0.673	0.985	1.022	1.019	1.348	97.2
28	16397	12228	126.60	57.41	855.60	118.33	0.685	0.676	0.986	1.019	1.016	1.346	100.7
29	18145	13531	136.20	61.79	915.30	126.59	0.686	0.679	0.990	1.017	1.015	1.345	104.1
30	20077	14971	147.10	66.73	980.20	135.56	0.688	0.684	0.994	1.014	1.013	1.343	107.6
31	22143	16512	158.70	72.00	1047.50	144.87	0.690	0.689	0.999	1.011	1.011	1.340	111.0
32	24373	18175	170.90	77.50	1117.40	154.54	0.692	0.695	1.004	1.009	1.010	1.338	114.6
33	26894	20055	184.50	83.69	1195.40	165.32	0.694	0.700	1.008	1.007	1.009	1.335	118.2
34	29753	22187	199.70	90.59	1283.70	177.54	0.697	0.703	1.009	1.004	1.006	1.332	121.7
35	33140	24712	217.80	98.79	1386.40	191.74	0.700	0.707	1.010	1.002	1.004	1.326	125.5
36	37175	27722	238.20	108.07	1507.00	208.42	0.704	0.709	1.007	1.001	1.003	1.321	129.6
37	42016	31331	262.80	119.22	1650.70	228.29	0.708	0.710	1.002	0.999	1.000	1.313	133.7
38	47613	35505	289.80	131.43	1811.00	250.46	0.712	0.709	0.996	0.999	0.998	1.305	138.1
39	54299	40491	321.70	145.93	1996.70	276.14	0.716	0.709	0.991	1.000	0.997	1.297	142.8
40	61813	46094	356.00	161.49	2195.80	303.68	0.718	0.709	0.987	1.003	0.999	1.289	147.9
41	69708	51981	390.80	177.28	2392.20	330.84	0.720	0.711	0.987	1.008	1.004	1.282	153.0
42	78718	58700	429.30	194.74	2608.40	360.74	0.722	0.713	0.987	1.014	1.010	1.276	158.5
43	88096	65693	466.80	211.74	2823.90	390.55	0.723	0.713	0.986	1.020	1.015	1.271	163.8
44	97626	72800	506.00	229.54	3042.00	420.71	0.725	0.714	0.985	1.020	1.015	1.264	168.6

Table B14a. JHSS BSS GB FA DES, Flap#4 @10°, Exp41, stock propeller powering prediction

JHSS BSS GB DES Flap#4 Exp41 StockProps

LENGTH (LWL)	977.9 FT (298.1 M)
DISPLACEMENT	36490.5 TONS (37074.2 TONNES)
WETTED SURFACE	106845.0 SQ FT (9926.2 SQ M)
INBOARD PROP DIA	21.33 FT (6.50 M)
OUTBOARD PROP DIA	21.33 FT (6.50 M)
ITTC FRICTION USED	CORRELATION ALLOWANCE 0.00000

TOTAL (ALL FOUR SHAFTS COMBINED)

SHIP SPEED		EFFECTIVE POWER		DELIVERED POWER		PROPELLER	ETAD	ETAO+	ETAB+	1-t	CTS	CFS	CR
(KNOTS)	(M/SEC)	(HP)	(KW)	(HP)	(KW)	RPM							
15	7.72	7868	5867	12031	8972	55.0	0.654	0.698	0.704	0.925	2.508	1.413	1.095
16	8.23	9334	6960	14322	10680	58.3	0.652	0.697	0.694	0.928	2.451	1.402	1.049
17	8.75	10962	8174	16868	12578	61.5	0.650	0.695	0.688	0.929	2.400	1.392	1.008
18	9.26	12759	9514	19704	14694	64.9	0.648	0.693	0.684	0.929	2.353	1.383	0.971
19	9.77	14709	10968	22805	17006	68.3	0.645	0.692	0.682	0.927	2.307	1.374	0.933
20	10.29	16868	12578	26253	19577	71.7	0.643	0.691	0.681	0.922	2.268	1.366	0.903
21	10.80	19298	14391	30106	22450	75.3	0.641	0.690	0.683	0.918	2.242	1.358	0.884
22	11.32	22025	16424	34500	25726	78.8	0.638	0.690	0.683	0.913	2.225	1.350	0.875
23	11.83	25058	18686	39377	29364	82.3	0.636	0.691	0.685	0.906	2.216	1.344	0.872
24	12.35	28387	21168	44685	33321	85.8	0.635	0.692	0.688	0.899	2.209	1.337	0.872
25	12.86	31987	23853	50426	37603	89.3	0.634	0.692	0.690	0.894	2.202	1.331	0.872
26	13.38	35824	26714	56561	42178	92.8	0.633	0.693	0.691	0.891	2.193	1.325	0.868
27	13.89	39865	29727	63039	47008	96.2	0.632	0.693	0.691	0.888	2.179	1.319	0.860
28	14.40	44090	32878	69698	51973	99.5	0.633	0.693	0.691	0.887	2.161	1.313	0.847
29	14.92	48505	36170	76701	57196	102.8	0.632	0.692	0.689	0.888	2.139	1.308	0.831
30	15.43	53157	39639	83951	62602	106.1	0.633	0.691	0.689	0.888	2.118	1.303	0.815
31	15.95	58151	43363	91779	68440	109.3	0.634	0.691	0.686	0.890	2.100	1.298	0.802
32	16.46	63654	47467	100209	74726	112.6	0.635	0.690	0.685	0.893	2.090	1.293	0.796
33	16.98	69902	52126	109696	81800	115.8	0.637	0.691	0.684	0.896	2.092	1.289	0.804
34	17.49	77197	57566	120799	90080	119.3	0.639	0.692	0.683	0.899	2.113	1.284	0.828
35	18.01	85888	64047	133934	99874	122.9	0.641	0.695	0.683	0.901	2.155	1.280	0.875
36	18.52	96351	71849	149593	111552	126.7	0.644	0.698	0.684	0.902	2.222	1.276	0.945
37	19.03	108950	81244	168528	125672	130.8	0.646	0.702	0.686	0.902	2.314	1.272	1.042
38	19.55	123990	92459	190916	142366	135.3	0.649	0.707	0.690	0.902	2.431	1.268	1.162
39	20.06	141663	105638	217339	162069	140.0	0.652	0.711	0.695	0.901	2.569	1.265	1.304
40	20.58	161993	120798	247417	184499	145.1	0.655	0.715	0.702	0.899	2.723	1.261	1.462
41	21.09	184792	137799	280991	209535	150.5	0.658	0.717	0.710	0.896	2.884	1.258	1.627
42	21.61	209631	156322	317161	236507	155.9	0.661	0.720	0.719	0.893	3.044	1.254	1.790
43	22.12	235856	175878	355065	264772	161.3	0.664	0.721	0.726	0.891	3.191	1.251	1.940
44	22.64	262665	195869	393814	293667	166.0	0.667	0.722	0.727	0.890	3.317	1.248	2.069

+ETAO and ETAB (TOTAL) = AVERAGE OF INBOARD AND OUTBOARD VALUES

Table B14a. JHSS BSS GB FA DES, Flap#4 @10°, Exp41, stock propeller powering prediction (continued)

JHSS BSS GB DES Flap#4 Exp41 StockProps													
INBOARD (PER SHAFT)													
SPEED (KNOTS)	DELIVERED (HP)	POWER (KW)	THRUST (LBS)	(X1000) (KG)	TORQUE (FT-LB)	(X1000) (KG-M)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER RPM
15	3093	2306	55.60	25.21	295.10	40.81	0.714	0.801	1.122	0.969	1.005	1.254	55.0
16	3704	2762	61.60	27.96	333.90	46.18	0.714	0.788	1.104	0.964	0.995	1.257	58.3
17	4392	3275	68.20	30.95	374.90	51.85	0.713	0.778	1.091	0.960	0.987	1.259	61.5
18	5161	3849	75.20	34.11	417.70	57.77	0.712	0.771	1.082	0.958	0.982	1.262	64.9
19	6018	4488	82.40	37.40	462.80	64.01	0.712	0.765	1.075	0.957	0.979	1.265	68.3
20	6970	5198	90.30	40.95	510.40	70.58	0.711	0.761	1.070	0.957	0.977	1.267	71.7
21	8041	5996	98.90	44.86	561.10	77.60	0.711	0.759	1.067	0.957	0.977	1.268	75.3
22	9270	6912	108.30	49.13	618.00	85.46	0.711	0.754	1.062	0.956	0.975	1.268	78.8
23	10636	7931	118.50	53.75	678.70	93.86	0.711	0.751	1.057	0.955	0.972	1.268	82.3
24	12131	9046	129.30	58.67	742.40	102.67	0.711	0.749	1.053	0.954	0.969	1.266	85.8
25	13740	10246	140.50	63.72	807.90	111.73	0.711	0.747	1.050	0.952	0.967	1.266	89.3
26	15468	11535	151.70	68.81	875.80	121.12	0.711	0.744	1.046	0.951	0.964	1.265	92.8
27	17303	12902	163.00	73.93	944.80	130.67	0.711	0.741	1.042	0.949	0.962	1.266	96.2
28	19170	14295	173.80	78.85	1011.60	139.90	0.711	0.739	1.039	0.948	0.960	1.267	99.5
29	21126	15754	184.40	83.64	1079.70	149.32	0.711	0.735	1.034	0.946	0.957	1.268	102.8
30	23152	17264	195.10	88.48	1146.30	158.53	0.710	0.734	1.033	0.946	0.956	1.270	106.1
31	25327	18886	205.70	93.30	1217.20	168.34	0.709	0.729	1.028	0.944	0.953	1.272	109.3
32	27628	20602	216.90	98.40	1289.10	178.28	0.709	0.727	1.026	0.943	0.951	1.273	112.6
33	30234	22546	229.80	104.23	1371.00	189.61	0.709	0.724	1.022	0.941	0.948	1.273	115.8
34	33217	24770	244.30	110.84	1462.00	202.19	0.709	0.722	1.018	0.941	0.946	1.273	119.3
35	36767	27417	262.40	119.00	1570.80	217.24	0.710	0.720	1.013	0.939	0.943	1.270	122.9
36	40966	30548	283.90	128.78	1697.80	234.81	0.712	0.718	1.009	0.937	0.940	1.265	126.7
37	46009	34309	309.90	140.59	1847.10	255.45	0.713	0.716	1.004	0.936	0.938	1.258	130.8
38	51922	38718	340.80	154.58	2016.00	278.81	0.715	0.717	1.002	0.936	0.937	1.249	135.3
39	58928	43943	377.00	170.99	2211.00	305.78	0.717	0.717	1.000	0.937	0.937	1.239	140.0
40	66829	49834	417.60	189.44	2418.80	334.52	0.718	0.721	1.003	0.939	0.940	1.230	145.1
41	75610	56383	463.00	210.03	2639.30	365.02	0.719	0.726	1.009	0.942	0.946	1.219	150.5
42	85078	63442	512.10	232.30	2865.50	396.30	0.720	0.733	1.019	0.945	0.953	1.209	155.9
43	94950	70804	563.50	255.60	3091.90	427.61	0.721	0.742	1.030	0.947	0.959	1.199	161.3
44	105096	78348	616.40	279.59	3325.10	459.86	0.721	0.747	1.037	0.943	0.958	1.187	166.0

Table B14a. JHSS BSS GB FA DES, Flap#4 @10°, Exp41, stock propeller powering prediction (continued)

JHSS BSS GB DES Flap#4 Exp41 StockProps													
OUTBOARD (PER SHAFT)													
SPEED (KNOTS)	DELIVERED (HP)	POWER (KW)	THRUST (X1000) (LBS)	(KG)	TORQUE (X1000) (FT-LB)	(KG-M)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER RPM
15	2923	2179	36.80	16.71	278.90	38.57	0.681	0.606	0.889	1.044	1.016	1.351	55.0
16	3457	2578	40.80	18.50	311.60	43.10	0.679	0.601	0.885	1.038	1.009	1.353	58.3
17	4042	3014	44.90	20.37	345.00	47.72	0.677	0.599	0.884	1.033	1.005	1.356	61.5
18	4691	3498	49.10	22.29	379.60	52.50	0.674	0.597	0.885	1.031	1.004	1.358	64.9
19	5384	4015	53.70	24.35	414.00	57.26	0.672	0.599	0.891	1.030	1.004	1.361	68.3
20	6156	4591	58.70	26.64	450.70	62.34	0.670	0.602	0.898	1.029	1.005	1.362	71.7
21	7012	5229	64.30	29.15	489.40	67.68	0.669	0.607	0.908	1.029	1.008	1.363	75.3
22	7980	5951	70.40	31.92	532.00	73.57	0.669	0.612	0.914	1.028	1.009	1.363	78.8
23	9053	6751	77.40	35.13	577.70	79.89	0.671	0.620	0.924	1.026	1.009	1.362	82.3
24	10211	7614	85.00	38.54	624.90	86.43	0.672	0.628	0.934	1.024	1.010	1.360	85.8
25	11473	8555	92.70	42.03	674.60	93.29	0.674	0.634	0.941	1.023	1.010	1.359	89.3
26	12813	9554	100.30	45.50	725.40	100.32	0.674	0.638	0.946	1.021	1.009	1.358	92.8
27	14217	10602	108.00	48.98	776.30	107.36	0.674	0.641	0.951	1.019	1.008	1.358	96.2
28	15679	11692	115.40	52.33	827.40	114.43	0.674	0.643	0.954	1.017	1.007	1.359	99.5
29	17225	12845	122.60	55.63	880.30	121.75	0.674	0.643	0.954	1.014	1.004	1.359	102.8
30	18823	14037	129.90	58.94	932.00	128.90	0.673	0.644	0.957	1.013	1.004	1.360	106.1
31	20563	15334	137.60	62.39	988.20	136.67	0.672	0.643	0.956	1.010	1.001	1.361	109.3
32	22477	16761	145.90	66.16	1048.80	145.05	0.672	0.642	0.956	1.008	0.998	1.361	112.6
33	24613	18354	155.60	70.58	1116.10	154.36	0.673	0.643	0.955	1.005	0.995	1.359	115.8
34	27182	20270	167.20	75.86	1196.40	165.46	0.676	0.644	0.953	1.003	0.993	1.357	119.3
35	30200	22520	181.60	82.36	1290.30	178.45	0.679	0.646	0.951	1.001	0.990	1.353	122.9
36	33831	25228	199.50	90.49	1402.10	193.91	0.685	0.651	0.950	0.999	0.987	1.347	126.7
37	38255	28527	221.70	100.57	1535.80	212.40	0.691	0.656	0.949	0.997	0.985	1.339	130.8
38	43536	32465	248.40	112.69	1690.40	233.78	0.698	0.664	0.950	0.997	0.985	1.330	135.3
39	49741	37092	280.20	127.11	1866.30	258.11	0.705	0.672	0.954	0.997	0.985	1.319	140.0
40	56880	42415	316.60	143.62	2058.70	284.72	0.711	0.683	0.961	0.999	0.988	1.308	145.1
41	64885	48385	356.80	161.86	2264.90	313.24	0.715	0.693	0.969	1.002	0.993	1.297	150.5
42	73503	54811	399.00	181.00	2475.70	342.39	0.719	0.704	0.979	1.006	1.000	1.287	155.9
43	82583	61582	439.80	199.50	2689.20	371.92	0.721	0.710	0.984	1.010	1.005	1.279	161.3
44	91841	68486	476.30	216.06	2906.50	401.97	0.723	0.708	0.979	1.011	1.004	1.273	166.0

Table B14b. JHSS BSS GB FA DES, Flap#4 @10°, stock propeller powering prediction, SAD included

JHSS BSS GB DES Flap#4 Exp41 StockProps w/SAD

LENGTH (LWL)	977.9 FT (298.1 M)
DISPLACEMENT	36490.5 TONS (37074.2 TONNES)
WETTED SURFACE	106845.0 SQ FT (9926.2 SQ M)
INBOARD PROP DIA	21.33 FT (6.50 M)
OUTBOARD PROP DIA	21.33 FT (6.50 M)
ITTC FRICTION USED	CORRELATION ALLOWANCE 0.00000

TOTAL (ALL FOUR SHAFTS COMBINED)

SHIP SPEED		EFFECTIVE POWER		DELIVERED POWER		PROPELLER	ETAD	ETAO+	ETAB+	1-t	CTS	CFS	CR
(KNOTS)	(M/SEC)	(HP)	(KW)	(HP)	(KW)	RPM							
15	7.72	8085	6029	11871	8852	54.9	0.681	0.696	0.702	0.965	2.577	1.413	1.164
16	8.23	9597	7156	14143	10547	58.2	0.679	0.695	0.693	0.968	2.521	1.402	1.118
17	8.75	11277	8409	16650	12416	61.4	0.677	0.693	0.687	0.970	2.469	1.392	1.077
18	9.26	13134	9794	19427	14487	64.8	0.676	0.691	0.682	0.972	2.423	1.383	1.040
19	9.77	15149	11297	22480	16763	68.2	0.674	0.690	0.680	0.970	2.376	1.374	1.002
20	10.29	17382	12962	25900	19313	71.6	0.671	0.688	0.679	0.966	2.337	1.366	0.972
21	10.80	19893	14834	29711	22156	75.1	0.670	0.688	0.681	0.961	2.311	1.358	0.953
22	11.32	22709	16934	34042	25385	78.6	0.667	0.688	0.681	0.956	2.294	1.350	0.944
23	11.83	25839	19268	38872	28987	82.1	0.665	0.689	0.684	0.948	2.285	1.344	0.941
24	12.35	29275	21830	44175	32941	85.7	0.663	0.690	0.687	0.940	2.278	1.337	0.941
25	12.86	32990	24601	49882	37197	89.2	0.661	0.691	0.689	0.934	2.271	1.331	0.941
26	13.38	36953	27556	55994	41755	92.6	0.660	0.691	0.689	0.930	2.262	1.325	0.937
27	13.89	41129	30670	62428	46552	96.0	0.659	0.691	0.690	0.926	2.248	1.319	0.929
28	14.40	45500	33929	69086	51518	99.4	0.659	0.691	0.690	0.925	2.230	1.313	0.916
29	14.92	50071	37338	76087	56738	102.6	0.658	0.691	0.687	0.925	2.209	1.308	0.901
30	15.43	54891	40932	83327	62137	106.0	0.659	0.690	0.687	0.926	2.187	1.303	0.884
31	15.95	60064	44790	91197	68005	109.2	0.659	0.690	0.685	0.927	2.169	1.298	0.871
32	16.46	65758	49036	99642	74303	112.5	0.660	0.689	0.684	0.929	2.159	1.293	0.865
33	16.98	72210	53847	109231	81454	115.8	0.661	0.690	0.683	0.930	2.162	1.289	0.873
34	17.49	79721	59448	120445	89816	119.3	0.662	0.692	0.682	0.932	2.182	1.284	0.897
35	18.01	88641	66100	133711	99709	122.9	0.663	0.694	0.682	0.932	2.224	1.280	0.944
36	18.52	99347	74083	149443	111440	126.7	0.665	0.698	0.684	0.931	2.291	1.276	1.014
37	19.03	112203	83670	168709	125806	130.8	0.665	0.702	0.686	0.928	2.383	1.272	1.111
38	19.55	127514	95087	191446	142761	135.3	0.666	0.707	0.690	0.925	2.500	1.268	1.232
39	20.06	145472	108478	218175	162693	140.1	0.667	0.711	0.695	0.921	2.638	1.265	1.373
40	20.58	166103	123863	248660	185426	145.2	0.668	0.715	0.702	0.916	2.792	1.261	1.531
41	21.09	189218	141100	282737	210837	150.6	0.669	0.718	0.710	0.911	2.953	1.258	1.696
42	21.61	214389	159870	318908	237810	156.1	0.672	0.720	0.719	0.907	3.113	1.254	1.859
43	22.12	240962	179685	356822	266082	161.4	0.675	0.721	0.726	0.905	3.260	1.251	2.009
44	22.64	268135	199948	395394	294845	166.1	0.678	0.722	0.728	0.905	3.386	1.248	2.139

+ETAO and ETAB (TOTAL) = AVERAGE OF INBOARD AND OUTBOARD VALUES

Table B14b. JHSS BSS GB FA DES, Flap#4 @10°, stock propeller powering prediction, SAD included (continued)

JHSS BSS GB DES Flap#4 Exp41 StockProps w/SAD													
INBOARD (PER SHAFT)													
SPEED (KNOTS)	DELIVERED (HP)	POWER (KW)	THRUST (X1000) (LBS)	(KG)	TORQUE (X1000) (FT-LB)	(KG-M)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER RPM
15	3056	2279	54.9	24.89	292.2	40.41	0.714	0.801	1.122	0.969	1.005	1.256	54.9
16	3664	2732	60.90	27.65	330.80	45.76	0.713	0.787	1.104	0.964	0.995	1.259	58.2
17	4338	3235	67.30	30.54	371.00	51.30	0.712	0.777	1.091	0.960	0.987	1.262	61.4
18	5096	3800	74.20	33.64	413.30	57.16	0.712	0.770	1.082	0.958	0.982	1.264	64.8
19	5946	4434	81.50	36.95	458.20	63.37	0.711	0.764	1.075	0.957	0.979	1.267	68.2
20	6888	5136	89.10	40.43	505.20	69.87	0.710	0.760	1.070	0.957	0.977	1.269	71.6
21	7959	5935	97.80	44.35	556.40	76.95	0.710	0.758	1.067	0.957	0.976	1.270	75.1
22	9168	6836	107.10	48.59	612.40	84.69	0.710	0.754	1.062	0.956	0.974	1.270	78.6
23	10518	7843	117.10	53.13	672.40	93.00	0.710	0.751	1.057	0.955	0.972	1.270	82.1
24	12000	8949	127.80	57.96	735.60	101.73	0.710	0.748	1.053	0.954	0.970	1.269	85.7
25	13632	10165	139.30	63.20	802.70	111.01	0.711	0.747	1.050	0.952	0.967	1.267	89.2
26	15335	11435	150.30	68.17	869.30	120.22	0.711	0.744	1.046	0.951	0.965	1.267	92.6
27	17167	12802	161.80	73.38	938.80	129.84	0.711	0.741	1.042	0.949	0.962	1.267	96.0
28	19028	14189	172.50	78.24	1005.40	139.05	0.711	0.738	1.039	0.948	0.960	1.268	99.4
29	20981	15645	183.00	83.03	1073.70	148.49	0.710	0.734	1.034	0.946	0.956	1.269	102.6
30	23004	17154	193.60	87.83	1140.00	157.66	0.710	0.733	1.033	0.946	0.956	1.272	106.0
31	25193	18786	204.50	92.78	1212.00	167.62	0.709	0.729	1.028	0.944	0.952	1.273	109.2
32	27516	20518	216.10	98.03	1284.90	177.70	0.709	0.727	1.026	0.943	0.951	1.274	112.5
33	30139	22475	229.20	103.94	1367.40	189.11	0.709	0.725	1.022	0.941	0.947	1.274	115.8
34	33110	24690	243.40	110.41	1457.90	201.63	0.709	0.722	1.018	0.941	0.946	1.274	119.3
35	36725	27386	262.00	118.83	1569.50	217.06	0.710	0.719	1.013	0.939	0.943	1.270	122.9
36	40965	30548	284.20	128.93	1698.00	234.83	0.712	0.718	1.009	0.937	0.940	1.264	126.7
37	46048	34338	310.40	140.82	1848.80	255.69	0.714	0.716	1.004	0.936	0.937	1.257	130.8
38	52073	38831	342.10	155.16	2021.40	279.56	0.716	0.717	1.002	0.936	0.937	1.248	135.3
39	59104	44074	378.00	171.47	2216.20	306.50	0.717	0.717	1.000	0.937	0.937	1.239	140.1
40	67143	50069	419.90	190.47	2428.50	335.86	0.719	0.721	1.003	0.939	0.940	1.228	145.2
41	76052	56712	465.90	211.35	2652.30	366.81	0.720	0.726	1.009	0.942	0.945	1.218	150.6
42	85544	63790	515.50	233.82	2878.60	398.11	0.720	0.734	1.019	0.945	0.952	1.208	156.1
43	95371	71118	566.40	256.92	3103.10	429.16	0.721	0.742	1.030	0.947	0.959	1.198	161.4
44	105448	78626	618.70	280.63	3334.20	461.12	0.720	0.747	1.037	0.943	0.958	1.186	166.1

Table B14b. JHSS BSS GB FA DES, Flap#4 @10°, stock propeller powering prediction, SAD included (continued)

JHSS BSS GB DES Flap#4 Exp41 StockProps w/SAD													
OUTBOARD (PER SHAFT)													
SPEED (KNOTS)	DELIVERED (HP)	POWER (KW)	THRUST (LBS)	(X1000) (KG)	TORQUE (FT-LB)	(X1000) (KG-M)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER RPM
15	2879	2147	36.1	16.39	275.3	38.07	0.678	0.603	0.889	1.044	1.016	1.354	54.9
16	3407	2541	40.00	18.15	307.70	42.55	0.676	0.598	0.885	1.038	1.010	1.356	58.2
17	3987	2973	44.10	20.00	341.00	47.16	0.674	0.596	0.884	1.033	1.005	1.358	61.4
18	4617	3443	48.10	21.84	374.50	51.79	0.671	0.594	0.885	1.031	1.004	1.361	64.8
19	5294	3948	52.50	23.80	408.00	56.42	0.668	0.595	0.891	1.030	1.005	1.364	68.2
20	6062	4520	57.50	26.06	444.60	61.49	0.667	0.599	0.898	1.029	1.006	1.365	71.6
21	6897	5143	62.80	28.50	482.20	66.68	0.665	0.604	0.908	1.029	1.008	1.366	75.1
22	7853	5856	68.80	31.21	524.60	72.55	0.665	0.608	0.914	1.028	1.009	1.366	78.6
23	8919	6651	75.90	34.45	570.20	78.86	0.667	0.617	0.924	1.026	1.009	1.364	82.1
24	10087	7522	83.70	37.95	618.30	85.52	0.670	0.625	0.934	1.024	1.010	1.362	85.7
25	11309	8433	90.90	41.22	666.00	92.11	0.670	0.631	0.941	1.023	1.010	1.362	89.2
26	12662	9442	98.70	44.77	717.80	99.27	0.671	0.635	0.946	1.021	1.009	1.361	92.6
27	14047	10474	106.30	48.20	768.10	106.23	0.672	0.639	0.951	1.019	1.008	1.360	96.0
28	15515	11570	113.70	51.59	819.80	113.38	0.671	0.641	0.954	1.017	1.007	1.360	99.4
29	17063	12724	121.10	54.92	873.20	120.76	0.671	0.640	0.954	1.014	1.004	1.361	102.6
30	18660	13914	128.30	58.20	924.70	127.89	0.670	0.641	0.957	1.013	1.004	1.362	106.0
31	20405	15216	136.00	61.69	981.60	135.76	0.670	0.640	0.956	1.010	1.001	1.362	109.2
32	22305	16633	144.30	65.46	1041.60	144.05	0.670	0.640	0.956	1.008	0.999	1.362	112.5
33	24477	18252	154.20	69.95	1110.50	153.58	0.671	0.641	0.955	1.005	0.995	1.360	115.8
34	27112	20218	166.50	75.53	1193.80	165.10	0.674	0.643	0.953	1.003	0.993	1.358	119.3
35	30131	22468	180.80	82.01	1287.70	178.09	0.678	0.645	0.951	1.001	0.990	1.354	122.9
36	33756	25172	198.70	90.14	1399.20	193.51	0.684	0.650	0.950	0.999	0.988	1.348	126.7
37	38306	28565	222.00	100.69	1538.00	212.71	0.691	0.656	0.949	0.997	0.985	1.339	130.8
38	43650	32550	249.00	112.95	1694.40	234.34	0.698	0.663	0.950	0.997	0.984	1.330	135.3
39	49983	37272	281.90	127.85	1874.20	259.20	0.705	0.673	0.954	0.997	0.985	1.318	140.1
40	57187	42644	318.70	144.58	2068.40	286.06	0.711	0.683	0.961	0.999	0.988	1.307	145.2
41	65317	48707	359.50	163.05	2277.90	315.03	0.716	0.694	0.969	1.002	0.993	1.295	150.6
42	73910	55115	401.50	182.12	2487.10	343.97	0.719	0.704	0.979	1.006	1.000	1.286	156.1
43	83040	61923	442.50	200.72	2701.90	373.67	0.722	0.710	0.984	1.010	1.005	1.278	161.4
44	92258	68797	478.50	217.04	2917.40	403.48	0.723	0.708	0.979	1.011	1.004	1.272	166.1

Table B15a. JHSS BSS GB FA HVY, Flap#4 @10°, Exp45, stock propeller powering prediction

JHSS BSS GB HVY Flap#4 Exp45 StockProps

LENGTH (LWL)	947.9 FT (288.9 M)
DISPLACEMENT	40140 TONS (40782.4 TONNES)
WETTED SURFACE	110463.5 SQ FT (10262.4 SQ M)
INBOARD PROP DIA	21.33 FT (6.50 M)
OUTBOARD PROP DIA	21.33 FT (6.50 M)
ITTC FRICTION USED	CORRELATION ALLOWANCE 0.00000

TOTAL (ALL FOUR SHAFTS COMBINED)

SHIP SPEED		EFFECTIVE POWER		DELIVERED POWER		PROPELLER	ETAD	ETAO+	ETAB+	1-t	CTS	CFS	CR
(KNOTS)	(M/SEC)	(HP)	(KW)	(HP)	(KW)	RPM							
15	7.72	8271	6168	12698	9469	55.4	0.651	0.708	0.719	0.899	2.55	1.418	1.132
16	8.23	9872	7362	15157	11302	58.8	0.651	0.706	0.709	0.91	2.508	1.407	1.101
17	8.75	11675	8706	17925	13366	62.1	0.651	0.705	0.701	0.916	2.473	1.397	1.075
18	9.26	13652	10180	20942	15616	65.4	0.652	0.704	0.697	0.919	2.436	1.388	1.048
19	9.77	15794	11778	24249	18082	68.8	0.651	0.703	0.694	0.919	2.396	1.379	1.017
20	10.29	18119	13511	27867	20781	72.2	0.65	0.702	0.694	0.917	2.357	1.371	0.986
21	10.8	20661	15407	31833	23738	75.6	0.649	0.701	0.694	0.913	2.321	1.363	0.959
22	11.32	23462	17496	36254	27034	79.1	0.647	0.7	0.696	0.907	2.293	1.355	0.937
23	11.83	26561	19807	41163	30696	82.7	0.645	0.7	0.698	0.901	2.271	1.348	0.923
24	12.35	29982	22358	46635	34775	86.2	0.643	0.7	0.7	0.894	2.257	1.342	0.915
25	12.86	33729	25152	52622	39240	89.8	0.641	0.7	0.702	0.888	2.246	1.335	0.911
26	13.38	37780	28173	59068	44047	93.3	0.64	0.7	0.704	0.882	2.237	1.329	0.907
27	13.89	42096	31391	65958	49185	96.8	0.638	0.701	0.706	0.876	2.225	1.324	0.902
28	14.4	46634	34775	73090	54504	100.1	0.638	0.701	0.707	0.871	2.21	1.318	0.892
29	14.92	51367	38304	80533	60054	103.5	0.638	0.701	0.709	0.867	2.191	1.313	0.879
30	15.43	56312	41992	88230	65793	106.8	0.638	0.701	0.71	0.865	2.17	1.308	0.863
31	15.95	61552	45899	96226	71756	110.1	0.64	0.701	0.712	0.864	2.15	1.303	0.847
32	16.46	67267	50161	104995	78295	113.4	0.641	0.701	0.712	0.864	2.136	1.298	0.838
33	16.98	73743	54990	114706	85537	116.9	0.643	0.701	0.714	0.864	2.135	1.293	0.842
34	17.49	81371	60678	126021	93974	120.4	0.646	0.702	0.715	0.866	2.154	1.289	0.865
35	18.01	90631	67584	139667	104150	124.1	0.649	0.704	0.715	0.87	2.199	1.285	0.915
36	18.52	102041	76092	156434	116653	128.1	0.652	0.707	0.715	0.874	2.276	1.281	0.995
37	19.03	116088	86567	177053	132029	132.3	0.656	0.71	0.715	0.879	2.385	1.277	1.108
38	19.55	133138	99281	202023	150649	136.8	0.659	0.714	0.714	0.884	2.525	1.273	1.252
39	20.06	153337	114343	231499	172629	141.7	0.662	0.717	0.714	0.889	2.69	1.269	1.421
40	20.58	176523	131633	265003	197612	146.9	0.666	0.719	0.716	0.893	2.87	1.266	1.604
41	21.09	202186	150770	302026	225221	152.1	0.669	0.721	0.717	0.898	3.052	1.262	1.79
42	21.61	229526	171158	341767	254855	157.4	0.672	0.722	0.721	0.897	3.224	1.259	1.965
43	22.12	257675	192148	382781	285440	162.4	0.673	0.723	0.724	0.895	3.372	1.255	2.117

+ETAO and ETAB (TOTAL) = AVERAGE OF INBOARD AND OUTBOARD VALUES

Table B15a. JHSS BSS GB FA HVY, Flap#4 @10°, Exp45, stock propeller powering prediction (continued)

JHSS BSS GB HVY Flap#4 Exp45 StockProps													
INBOARD (PER SHAFT)													
SPEED (KNOTS)	DELIVERED (HP)	POWER (KW)	THRUST (LBS)	(X1000) (KG)	TORQUE (FT-LB)	(X1000) (KG-M)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER RPM
15	3395	2532	57.40	26.06	322.00	44.53	0.716	0.756	1.056	0.970	0.988	1.248	55.4
16	4053	3022	63.60	28.86	362.20	50.09	0.715	0.747	1.045	0.969	0.983	1.252	58.8
17	4793	3574	70.60	32.00	405.40	56.06	0.714	0.741	1.038	0.965	0.977	1.255	62.1
18	5595	4172	77.90	35.34	449.30	62.14	0.714	0.739	1.035	0.961	0.972	1.256	65.4
19	6484	4835	85.70	38.88	495.20	68.48	0.713	0.739	1.035	0.958	0.970	1.257	68.8
20	7463	5565	94.00	42.65	543.10	75.11	0.713	0.739	1.037	0.956	0.968	1.259	72.2
21	8538	6366	102.90	46.67	593.10	82.03	0.713	0.742	1.040	0.955	0.967	1.259	75.6
22	9760	7278	112.50	51.05	647.70	89.57	0.713	0.743	1.042	0.954	0.968	1.260	79.1
23	11123	8294	123.00	55.78	706.60	97.72	0.713	0.744	1.044	0.953	0.967	1.260	82.7
24	12640	9426	134.40	60.98	770.10	106.50	0.713	0.745	1.045	0.952	0.966	1.258	86.2
25	14316	10676	146.50	66.47	837.30	115.80	0.714	0.746	1.046	0.951	0.965	1.257	89.8
26	16118	12019	159.10	72.17	907.10	125.45	0.714	0.747	1.046	0.949	0.963	1.255	93.3
27	18051	13461	172.10	78.07	979.80	135.51	0.714	0.747	1.046	0.946	0.960	1.253	96.8
28	20032	14938	184.90	83.85	1050.80	145.33	0.715	0.748	1.046	0.943	0.958	1.252	100.1
29	22103	16482	197.40	89.54	1121.20	155.06	0.715	0.749	1.048	0.942	0.957	1.253	103.5
30	24231	18069	209.50	95.02	1191.70	164.81	0.714	0.748	1.047	0.940	0.954	1.253	106.8
31	26440	19716	221.30	100.37	1261.20	174.42	0.714	0.748	1.047	0.939	0.953	1.255	110.1
32	28845	21510	233.60	105.97	1336.00	184.77	0.714	0.746	1.045	0.938	0.952	1.257	113.4
33	31460	23460	247.30	112.20	1414.00	195.56	0.713	0.747	1.047	0.938	0.952	1.258	116.9
34	34479	25711	263.10	119.35	1504.10	208.02	0.714	0.746	1.046	0.937	0.951	1.257	120.4
35	38144	28444	282.00	127.93	1614.00	223.22	0.714	0.744	1.042	0.937	0.950	1.254	124.1
36	42588	31758	305.80	138.73	1746.70	241.57	0.715	0.742	1.037	0.935	0.947	1.249	128.1
37	48050	35831	334.60	151.76	1907.40	263.79	0.717	0.739	1.031	0.935	0.945	1.241	132.3
38	54654	40756	369.30	167.49	2098.20	290.18	0.718	0.735	1.024	0.933	0.942	1.231	136.8
39	62434	46557	409.60	185.79	2314.20	320.05	0.719	0.733	1.019	0.934	0.941	1.220	141.7
40	71294	53164	454.50	206.17	2548.90	352.51	0.720	0.732	1.016	0.935	0.941	1.209	146.9
41	81004	60405	502.20	227.79	2797.00	386.83	0.721	0.730	1.014	0.936	0.942	1.198	152.1
42	91518	68245	555.80	252.12	3053.50	422.30	0.720	0.733	1.017	0.936	0.944	1.186	157.4
43	102391	76371	608.70	276.11	3311.30	457.95	0.720	0.733	1.019	0.935	0.943	1.176	162.4

Table B15a. JHSS BSS GB FA HVY, Flap#4 @10°, Exp45, stock propeller powering prediction (continued)

JHSS BSS GB HVY Flap#4 Exp45 StockProps													
OUTBOARD (PER SHAFT)													
SPEED (KNOTS)	DELIVERED (HP)	POWER (KW)	THRUST (X1000) (LBS)	(KG)	TORQUE (X1000) (FT-LB)	(KG-M)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER RPM
15	2954	2203	42.5	19.28	280.1	38.74	0.701	0.683	0.974	1.031	1.025	1.326	55.4
16	3526	2629	46.80	21.25	315.10	43.58	0.698	0.671	0.962	1.029	1.019	1.330	58.8
17	4170	3109	51.60	23.39	352.70	48.77	0.696	0.662	0.951	1.026	1.013	1.333	62.1
18	4876	3636	56.50	25.62	391.60	54.15	0.694	0.654	0.942	1.022	1.007	1.336	65.4
19	5641	4206	61.60	27.95	430.80	59.58	0.692	0.650	0.939	1.020	1.005	1.338	68.8
20	6471	4825	67.00	30.41	470.90	65.13	0.690	0.648	0.938	1.019	1.004	1.341	72.2
21	7379	5502	72.70	32.99	512.60	70.89	0.689	0.647	0.939	1.018	1.003	1.343	75.6
22	8367	6240	79.00	35.83	555.30	76.79	0.687	0.649	0.944	1.019	1.005	1.345	79.1
23	9459	7054	85.80	38.90	600.90	83.10	0.687	0.652	0.949	1.019	1.007	1.346	82.7
24	10677	7962	93.10	42.24	650.50	89.96	0.686	0.654	0.953	1.018	1.007	1.346	86.2
25	11995	8944	101.00	45.82	701.50	97.02	0.686	0.658	0.958	1.018	1.008	1.346	89.8
26	13416	10004	109.40	49.63	755.10	104.43	0.687	0.662	0.963	1.017	1.008	1.345	93.3
27	14928	11132	117.90	53.50	810.20	112.05	0.687	0.664	0.967	1.015	1.007	1.345	96.8
28	16513	12314	126.70	57.47	866.20	119.80	0.688	0.667	0.970	1.012	1.005	1.344	100.1
29	18164	13545	135.40	61.40	921.30	127.42	0.688	0.670	0.975	1.011	1.005	1.344	103.5
30	19884	14828	144.30	65.44	977.90	135.24	0.688	0.673	0.978	1.007	1.003	1.344	106.8
31	21673	16162	153.30	69.55	1033.80	142.97	0.688	0.677	0.984	1.005	1.002	1.344	110.1
32	23652	17637	162.90	73.91	1095.40	151.49	0.688	0.678	0.986	1.003	1.000	1.344	113.4
33	25893	19308	173.90	78.87	1163.70	160.94	0.689	0.681	0.989	1.001	0.999	1.343	116.9
34	28531	21276	186.90	84.79	1244.60	172.13	0.691	0.683	0.989	1.000	0.997	1.340	120.4
35	31689	23631	202.80	92.01	1340.90	185.45	0.694	0.686	0.989	0.998	0.995	1.336	124.1
36	35629	26568	222.70	101.01	1461.30	202.10	0.698	0.688	0.985	0.996	0.993	1.330	128.1
37	40477	30184	247.20	112.13	1606.80	222.22	0.703	0.690	0.981	0.995	0.991	1.322	132.3
38	46357	34569	276.60	125.46	1779.70	246.13	0.709	0.692	0.976	0.995	0.988	1.312	136.8
39	53316	39758	311.30	141.20	1976.20	273.31	0.714	0.695	0.974	0.995	0.988	1.301	141.7
40	61208	45643	350.40	158.95	2188.30	302.64	0.718	0.701	0.976	0.997	0.990	1.289	146.9
41	70009	52206	392.70	178.13	2417.40	334.33	0.722	0.704	0.976	0.998	0.991	1.278	152.1
42	79366	59183	436.90	198.18	2648.00	366.22	0.724	0.710	0.980	1.000	0.994	1.267	157.4
43	88976	66350	481.90	218.60	2876.80	397.86	0.726	0.715	0.985	1.000	0.995	1.257	162.4

Table B15b. JHSS BSS GB FA HVY, Flap#4 @10°, stock propeller powering prediction, SAD included

JHSS BSS GB HVY Flap#4 Exp45 StockProps w/SAD

LENGTH (LWL)	947.9 FT (288.9 M)
DISPLACEMENT	40140 TONS (40782.4 TONNES)
WETTED SURFACE	110463.5 SQ FT (10262.4 SQ M)
INBOARD PROP DIA	21.33 FT (6.50 M)
OUTBOARD PROP DIA	21.33 FT (6.50 M)
ITTC FRICTION USED	CORRELATION ALLOWANCE 0.00000

TOTAL (ALL FOUR SHAFTS COMBINED)

SHIP SPEED		EFFECTIVE POWER		DELIVERED POWER		PROPELLER	ETAD	ETAO+	ETAB+	1-t	CTS	CFS	CR
(KNOTS)	(M/SEC)	(HP)	(KW)	(HP)	(KW)	RPM							
15	7.72	8488	6330	12730	9493	55.4	0.667	0.708	0.719	0.920	2.617	1.418	1.199
16	8.23	10135	7558	15192	11329	58.8	0.667	0.706	0.709	0.932	2.575	1.407	1.167
17	8.75	11990	8941	17960	13392	62.1	0.668	0.705	0.702	0.939	2.539	1.397	1.142
18	9.26	14027	10460	20965	15634	65.4	0.669	0.704	0.696	0.944	2.503	1.388	1.115
19	9.77	16234	12106	24242	18077	68.8	0.670	0.703	0.694	0.945	2.463	1.379	1.084
20	10.29	18633	13895	27856	20772	72.2	0.669	0.702	0.693	0.943	2.423	1.371	1.053
21	10.8	21256	15851	31785	23702	75.6	0.669	0.701	0.694	0.941	2.388	1.363	1.025
22	11.32	24146	18006	36193	26989	79.1	0.667	0.699	0.695	0.936	2.360	1.355	1.004
23	11.83	27342	20389	41049	30610	82.6	0.666	0.699	0.697	0.931	2.338	1.348	0.990
24	12.35	30870	23020	46473	34655	86.2	0.664	0.699	0.699	0.925	2.324	1.342	0.982
25	12.86	34732	25900	52425	39094	89.8	0.663	0.699	0.701	0.919	2.313	1.335	0.978
26	13.38	38909	29014	58843	43879	93.3	0.661	0.700	0.703	0.913	2.303	1.329	0.974
27	13.89	43360	32334	65595	48914	96.7	0.661	0.700	0.705	0.908	2.292	1.324	0.969
28	14.4	48044	35826	72715	54223	100.0	0.661	0.700	0.707	0.903	2.277	1.318	0.959
29	14.92	52933	39472	80134	59756	103.5	0.661	0.700	0.709	0.899	2.258	1.313	0.946
30	15.43	58046	43285	87922	65564	106.7	0.660	0.701	0.710	0.895	2.237	1.308	0.929
31	15.95	63465	47326	95980	71572	110.1	0.661	0.700	0.712	0.893	2.217	1.303	0.914
32	16.46	69371	51730	104913	78234	113.4	0.661	0.700	0.712	0.892	2.203	1.298	0.905
33	16.98	76051	56711	114612	85466	116.8	0.664	0.701	0.714	0.892	2.202	1.293	0.909
34	17.49	83895	62560	126217	94120	120.4	0.665	0.702	0.715	0.892	2.221	1.289	0.932
35	18.01	93384	69636	140040	104428	124.2	0.667	0.704	0.715	0.894	2.266	1.285	0.982
36	18.52	105037	78326	156980	117060	128.1	0.669	0.707	0.715	0.896	2.343	1.281	1.062
37	19.03	119341	88993	177871	132638	132.4	0.671	0.710	0.715	0.899	2.452	1.277	1.175
38	19.55	136662	101909	202921	151318	136.9	0.673	0.714	0.714	0.903	2.591	1.273	1.319
39	20.06	157146	117184	232666	173499	141.8	0.675	0.717	0.715	0.906	2.757	1.269	1.487
40	20.58	180633	134698	266355	198621	147.0	0.678	0.719	0.717	0.909	2.937	1.266	1.671
41	21.09	206612	154071	303671	226447	152.2	0.680	0.721	0.718	0.912	3.119	1.262	1.857
42	21.61	234284	174706	343760	256342	157.6	0.682	0.722	0.721	0.910	3.290	1.259	2.032
43	22.12	262781	195956	384639	286825	162.6	0.683	0.723	0.724	0.908	3.439	1.255	2.184

+ETAO and ETAB (TOTAL) = AVERAGE OF INBOARD AND OUTBOARD VALUES

Table B15b. JHSS BSS GB FA HVY, Flap#4 @10°, stock propeller powering prediction, SAD included (continued)

JHSS BSS GB HVY Flap#4 Exp45 StockProps w/SAD													
INBOARD (PER SHAFT)													
SPEED (KNOTS)	DELIVERED (HP)	POWER (KW)	THRUST (LBS)	(X1000) (KG)	TORQUE (FT-LB)	(X1000) (KG-M)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER RPM
15	3402	2537	57.60	26.13	322.50	44.61	0.716	0.756	1.056	0.970	0.988	1.247	55.4
16	4061	3028	63.70	28.92	362.80	50.17	0.715	0.747	1.045	0.969	0.984	1.252	58.8
17	4806	3584	70.80	32.11	406.30	56.19	0.714	0.742	1.038	0.965	0.977	1.254	62.1
18	5601	4177	78.00	35.37	449.80	62.20	0.714	0.739	1.035	0.961	0.972	1.256	65.4
19	6487	4838	85.80	38.91	495.50	68.53	0.714	0.739	1.035	0.958	0.969	1.257	68.8
20	7466	5567	94.10	42.70	543.40	75.15	0.713	0.740	1.037	0.956	0.968	1.258	72.2
21	8522	6355	102.70	46.57	592.10	81.89	0.713	0.741	1.040	0.955	0.967	1.260	75.6
22	9759	7278	112.60	51.07	647.80	89.60	0.713	0.743	1.042	0.954	0.967	1.260	79.1
23	11109	8284	122.90	55.77	706.00	97.63	0.713	0.744	1.044	0.953	0.967	1.259	82.6
24	12594	9391	133.90	60.72	767.50	106.15	0.713	0.745	1.045	0.952	0.966	1.259	86.2
25	14256	10631	145.80	66.15	834.20	115.37	0.713	0.746	1.046	0.951	0.965	1.258	89.8
26	16060	11976	158.40	71.84	904.30	125.06	0.714	0.747	1.046	0.949	0.963	1.256	93.3
27	17961	13394	171.20	77.66	975.60	134.93	0.714	0.747	1.046	0.946	0.960	1.254	96.7
28	19935	14865	183.90	83.41	1046.60	144.74	0.715	0.747	1.046	0.943	0.957	1.253	100.0
29	22008	16411	196.60	89.16	1117.00	154.48	0.714	0.749	1.048	0.942	0.957	1.254	103.5
30	24115	17982	208.40	94.52	1186.70	164.12	0.714	0.748	1.047	0.940	0.955	1.255	106.7
31	26368	19662	220.60	100.08	1258.30	174.02	0.714	0.747	1.047	0.939	0.954	1.256	110.1
32	28835	21502	233.50	105.90	1335.50	184.70	0.714	0.746	1.045	0.938	0.952	1.257	113.4
33	31408	23421	247.00	112.03	1411.70	195.24	0.713	0.747	1.047	0.938	0.952	1.258	116.8
34	34570	25779	264.00	119.77	1507.60	208.50	0.714	0.747	1.046	0.937	0.951	1.256	120.4
35	38223	28503	282.70	128.24	1616.60	223.58	0.714	0.744	1.042	0.937	0.950	1.254	124.2
36	42729	31863	307.00	139.25	1752.10	242.32	0.716	0.742	1.037	0.935	0.947	1.248	128.1
37	48188	35934	335.50	152.18	1911.70	264.39	0.717	0.739	1.031	0.935	0.945	1.241	132.4
38	54931	40962	371.50	168.50	2107.40	291.45	0.718	0.736	1.024	0.933	0.941	1.230	136.9
39	62655	46722	411.00	186.41	2320.40	320.91	0.720	0.733	1.019	0.934	0.941	1.220	141.8
40	71644	53425	456.80	207.20	2559.40	353.97	0.720	0.732	1.016	0.935	0.941	1.208	147.0
41	81387	60691	504.90	229.03	2807.90	388.33	0.721	0.731	1.014	0.936	0.942	1.197	152.2
42	92024	68622	558.90	253.51	3067.60	424.25	0.720	0.733	1.017	0.936	0.943	1.185	157.6
43	102882	76713	611.70	277.48	3323.10	459.58	0.720	0.734	1.019	0.935	0.943	1.174	162.6

Table B15b. JHSS BSS GB FA HVY, Flap#4 @10°, stock propeller powering prediction, SAD included (continued)

JHSS BSS GB HVY Flap#4 Exp45 StockProps w/SAD													
OUTBOARD (PER SHAFT)													
SPEED (KNOTS)	DELIVERED (HP)	POWER (KW)	THRUST (X1000) (LBS)	THRUST (X1000) (KG)	TORQUE (X1000) (FT-LB)	TORQUE (X1000) (KG-M)	ETAO	ETAB	ETAR	1-WT	1-WQ	JT	PROPELLER RPM
15	2962	2209	42.6	19.33	280.8	38.84	0.701	0.683	0.974	1.031	1.024	1.325	55.4
16	3535	2636	47.00	21.31	315.80	43.68	0.698	0.672	0.962	1.029	1.019	1.330	58.8
17	4174	3113	51.60	23.40	352.90	48.80	0.696	0.662	0.951	1.026	1.014	1.333	62.1
18	4881	3640	56.50	25.64	392.00	54.21	0.694	0.654	0.942	1.022	1.007	1.336	65.4
19	5634	4201	61.50	27.91	430.30	59.51	0.692	0.650	0.939	1.020	1.005	1.338	68.8
20	6462	4819	66.80	30.32	470.30	65.04	0.690	0.647	0.938	1.019	1.004	1.341	72.2
21	7371	5496	72.60	32.93	512.10	70.83	0.688	0.646	0.939	1.018	1.003	1.343	75.6
22	8337	6217	78.50	35.60	553.40	76.54	0.686	0.648	0.944	1.019	1.006	1.346	79.1
23	9416	7021	85.10	38.60	598.40	82.75	0.685	0.650	0.949	1.019	1.007	1.347	82.6
24	10642	7936	92.70	42.05	648.60	89.70	0.685	0.653	0.953	1.018	1.007	1.346	86.2
25	11957	8916	100.50	45.58	699.60	96.76	0.685	0.656	0.958	1.018	1.008	1.346	89.8
26	13362	9964	108.70	49.30	752.40	104.06	0.685	0.660	0.963	1.017	1.009	1.346	93.3
27	14836	11064	117.00	53.05	805.90	111.46	0.686	0.663	0.967	1.015	1.007	1.346	96.7
28	16423	12246	125.70	57.03	862.20	119.24	0.686	0.666	0.970	1.012	1.005	1.345	100.0
29	18059	13467	134.20	60.89	916.60	126.77	0.686	0.669	0.975	1.011	1.005	1.345	103.5
30	19847	14800	143.90	65.26	976.60	135.06	0.687	0.672	0.978	1.007	1.002	1.344	106.7
31	21622	16124	152.90	69.35	1031.80	142.70	0.687	0.676	0.984	1.005	1.001	1.344	110.1
32	23622	17615	162.50	73.71	1094.00	151.30	0.687	0.678	0.986	1.003	1.000	1.344	113.4
33	25898	19312	174.00	78.91	1164.10	161.00	0.689	0.681	0.989	1.001	0.999	1.342	116.8
34	28538	21281	186.70	84.67	1244.50	172.11	0.690	0.682	0.989	1.000	0.998	1.341	120.4
35	31796	23711	203.60	92.33	1344.80	185.99	0.694	0.686	0.989	0.998	0.995	1.336	124.2
36	35760	26667	223.60	101.41	1466.30	202.79	0.698	0.688	0.985	0.996	0.992	1.329	128.1
37	40747	30385	249.10	112.98	1616.50	223.56	0.704	0.691	0.981	0.995	0.990	1.321	132.4
38	46530	34697	277.50	125.85	1785.10	246.88	0.709	0.692	0.976	0.995	0.989	1.312	136.9
39	53678	40027	313.70	142.28	1987.90	274.93	0.714	0.696	0.974	0.995	0.988	1.299	141.8
40	61534	45886	352.60	159.96	2198.30	304.02	0.719	0.701	0.976	0.997	0.990	1.288	147.0
41	70448	52533	395.40	179.34	2430.50	336.14	0.722	0.705	0.976	0.998	0.990	1.276	152.2
42	79856	59549	439.90	199.53	2662.00	368.15	0.724	0.710	0.980	1.000	0.993	1.266	157.6
43	89446	66700	484.90	219.95	2889.30	399.59	0.726	0.715	0.985	1.000	0.995	1.256	162.6

Table B16a. JHSS BSS GB FA, stock propeller powering predictions, summary and comparisons

	JHSS BSS Pre-Test Estimate			JHSS BSS GB DES Exp34				Exp34 vs Pre-Test Est		
VS (kts)	PE (hP)	PD (hP)	RPM	PE (hP)	PD (hP)	RPM	VS (kts)	PE Ratio	PD Ratio	RPM delta
15				7821	11503	55.0	15			
16	10332	15641	56.9	9413	13912	58.2	16	0.911	0.889	1.3
17				11157	16594	61.6	17			
18	14636	22162	63.9	13050	19529	65.1	18	0.892	0.881	1.2
19				15111	22755	68.7	19			
20	20153	30511	71.1	17370	26332	72.3	20	0.862	0.863	1.2
21				19868	30341	75.9	21			
22	26865	40669	78.2	22645	34775	79.4	22	0.843	0.855	1.2
23				25733	39777	83.1	23			
24	34539	52309	85.2	29147	45295	86.6	24	0.844	0.866	1.4
25				32884	51376	90.1	25			
26	43518	65933	92.2	36921	57958	93.6	26	0.848	0.879	1.4
27				41223	64937	97.1	27			
28	53940	81753	99.1	45758	72334	100.6	28	0.848	0.885	1.5
29				50511	80078	104.0	29			
30	65368	99146	105.9	55505	88166	107.4	30	0.849	0.889	1.5
31				60825	96650	110.8	31			
32	77025	117014	112.5	66631	105914	114.3	32	0.865	0.905	1.8
33				73167	116236	117.9	33			
34	90502	137662	119.1	80763	128147	121.5	34	0.892	0.931	2.4
35	99446	151198	122.8	89809	142234	125.2	35	0.903	0.941	2.4
36	110476	167763	126.7	100723	159076	129.2	36	0.912	0.948	2.5
37	123934	187875	130.9	113898	179267	133.3	37	0.919	0.954	2.4
38	140135	212042	135.4	129630	203333	137.7	38	0.925	0.959	2.3
39	159226	240543	140.1	148049	231284	142.5	39	0.930	0.962	2.4
40	181253	273527	145.1	169060	263042	147.5	40	0.933	0.962	2.4
41	206097	310894	150.2	192319	297833	152.7	41	0.933	0.958	2.5
42	233272	351967	155.4	217294	335387	158.2	42	0.932	0.953	2.8
43	261896	395424	160.5	243439	374742	163.5	43	0.930	0.948	3.0
44	291039	439807	165.4	270583	415427	168.2	44	0.930	0.945	2.8

Table B16a. JHSS BSS GB FA, stock propeller powering predictions, summary and comparisons (continued)

	JHSS BSS GB DES Flap#4 Exp41			JHSS BSS GB HVY Flap#4 Exp45				Flap vs No Flap (Exp41vsExp34)			HVY vs DES (Exp45vsExp41)		
VS (kts)	PE (hP)	PD (hP)	RPM	PE (hP)	PD (hP)	RPM	VS (kts)	PE Ratio	PD Ratio	RPM delta	PE Ratio	PD Ratio	RPM delta
15	7868	12031	55.0	8271	12698	55.4	15	1.006	1.046	0.0	1.051	1.055	0.4
16	9334	14322	58.3	9872	15157	58.8	16	0.992	1.029	0.1	1.058	1.058	0.5
17	10962	16868	61.5	11675	17925	62.1	17	0.983	1.017	-0.1	1.065	1.063	0.6
18	12759	19704	64.9	13652	20942	65.4	18	0.978	1.009	-0.2	1.070	1.063	0.5
19	14709	22805	68.3	15794	24249	68.8	19	0.973	1.002	-0.4	1.074	1.063	0.5
20	16868	26253	71.7	18119	27867	72.2	20	0.971	0.997	-0.6	1.074	1.061	0.5
21	19298	30106	75.3	20661	31833	75.6	21	0.971	0.992	-0.6	1.071	1.057	0.3
22	22025	34500	78.8	23462	36254	79.1	22	0.973	0.992	-0.6	1.065	1.051	0.3
23	25058	39377	82.3	26561	41163	82.7	23	0.974	0.990	-0.8	1.060	1.045	0.4
24	28387	44685	85.8	29982	46635	86.2	24	0.974	0.987	-0.8	1.056	1.044	0.4
25	31987	50426	89.3	33729	52622	89.8	25	0.973	0.982	-0.8	1.054	1.044	0.5
26	35824	56561	92.8	37780	59068	93.3	26	0.970	0.976	-0.8	1.055	1.044	0.5
27	39865	63039	96.2	42096	65958	96.8	27	0.967	0.971	-0.9	1.056	1.046	0.6
28	44090	69698	99.5	46634	73090	100.1	28	0.964	0.964	-1.1	1.058	1.049	0.6
29	48505	76701	102.8	51367	80533	103.5	29	0.960	0.958	-1.2	1.059	1.050	0.7
30	53157	83951	106.1	56312	88230	106.8	30	0.958	0.952	-1.3	1.059	1.051	0.7
31	58151	91779	109.3	61552	96226	110.1	31	0.956	0.950	-1.5	1.058	1.048	0.8
32	63654	100209	112.6	67267	104995	113.4	32	0.955	0.946	-1.7	1.057	1.048	0.8
33	69902	109696	115.8	73743	114706	116.9	33	0.955	0.944	-2.1	1.055	1.046	1.1
34	77197	120799	119.3	81371	126021	120.4	34	0.956	0.943	-2.2	1.054	1.043	1.1
35	85888	133934	122.9	90631	139667	124.1	35	0.956	0.942	-2.3	1.055	1.043	1.2
36	96351	149593	126.7	102041	156434	128.1	36	0.957	0.940	-2.5	1.059	1.046	1.4
37	108950	168528	130.8	116088	177053	132.3	37	0.957	0.940	-2.5	1.066	1.051	1.5
38	123990	190916	135.3	133138	202023	136.8	38	0.956	0.939	-2.4	1.074	1.058	1.5
39	141663	217339	140.0	153337	231499	141.7	39	0.957	0.940	-2.5	1.082	1.065	1.7
40	161993	247417	145.1	176523	265003	146.9	40	0.958	0.941	-2.4	1.090	1.071	1.8
41	184792	280991	150.5	202186	302026	152.1	41	0.961	0.943	-2.2	1.094	1.075	1.6
42	209631	317161	155.9	229526	341767	157.4	42	0.965	0.946	-2.3	1.095	1.078	1.5
43	235856	355065	161.3	257675	382781	162.4	43	0.969	0.947	-2.2	1.093	1.078	1.1
44	262665	393814	166.0				44	0.971	0.948	-2.2			

Table B16b. JHSS BSS GB FA, stock propeller powering predictions, SAD included, summary and comparisons

	Pre-Test Estimate w/SAD			BSS GB DES w/SAD				Test Results vs Pre-Test Est		
VS (kts)	PE (hP)	PD (hP)	RPM	PE (hP)	PD (hP)	RPM	VS (kts)	PE Ratio	PD Ratio	RPM delta
15				8038	11582	55.0	15			
16	10598	16028	57.1	9676	14033	58.3	16	0.913	0.876	+1.2
17				11472	16759	61.7	17			
18	15016	22714	64.2	13425	19743	65.2	18	0.894	0.869	+1.0
19				15551	22984	68.8	19			
20	20673	31267	71.4	17884	26566	72.4	20	0.865	0.850	+1.0
21				20463	30578	76.0	21			
22	27557	41677	78.6	23329	35024	79.5	22	0.847	0.840	+0.9
23				26514	40018	83.1	23			
24	35438	53614	85.6	30035	45551	86.7	24	0.848	0.850	+1.1
25				33887	51639	90.2	25			
26	44660	67589	92.6	38050	58217	93.7	26	0.852	0.861	+1.1
27				42487	65240	97.2	27			
28	55367	83818	99.5	47168	72782	100.7	28	0.852	0.868	+1.2
29				52077	80637	104.1	29			
30	67124	101680	106.4	57239	88914	107.6	30	0.853	0.874	+1.2
31				62738	97652	111.0	31			
32	79155	120070	113	68735	107292	114.6	32	0.868	0.894	+1.6
33				75475	117860	118.2	33			
34	93057	141312	119.6	83287	130066	121.7	34	0.895	0.920	+2.1
35	102234	155186	123.3	92562	144597	125.5	35	0.905	0.932	+2.2
36	113510	172121	127.2	103719	161728	129.6	36	0.914	0.940	+2.4
37	127227	192638	131.5	117151	182349	133.7	37	0.921	0.947	+2.2
38	143703	217249	136	133154	206639	138.1	38	0.927	0.951	+2.1
39	163083	246233	140.7	151858	235042	142.8	39	0.931	0.955	+2.1
40	185413	279735	145.7	173170	267206	147.9	40	0.934	0.955	+2.2
41	210578	317661	150.8	196745	301934	153.0	41	0.934	0.950	+2.2
42	238089	359326	156	222052	339657	158.5	42	0.933	0.945	+2.5
43	267065	403402	161.1	248545	379271	163.8	43	0.931	0.940	+2.7
44	296577	448426	166.1	276053	419945	168.6	44	0.931	0.936	+2.5

Table B16b. JHSS BSS GB FA, stock propeller powering predictions, SAD included, summary and comparisons (continued)

	BSS GB DES Flap#4 w/SAD			BSS GB HVY Flap#4 w/SAD				Flap vs No Flap			HVY vs DES (w/Flap)		
VS (kts)	PE (hP)	PD (hP)	RPM	PE (hP)	PD (hP)	RPM	VS (kts)	PE Ratio	PD Ratio	RPM delta	PE Ratio	PD Ratio	RPM delta
15	8085	11871	54.9	8488	12730	55.4	15	1.006	1.025	-0.1	1.050	1.072	+0.5
16	9597	14143	58.2	10135	15192	58.8	16	0.992	1.008	-0.1	1.056	1.074	+0.6
17	11277	16650	61.4	11990	17960	62.1	17	0.983	0.993	-0.3	1.063	1.079	+0.7
18	13134	19427	64.8	14027	20965	65.4	18	0.978	0.984	-0.4	1.068	1.079	+0.6
19	15149	22480	68.2	16234	24242	68.8	19	0.974	0.978	-0.6	1.072	1.078	+0.6
20	17382	25900	71.6	18633	27856	72.2	20	0.972	0.975	-0.8	1.072	1.076	+0.6
21	19893	29711	75.1	21256	31785	75.6	21	0.972	0.972	-0.9	1.069	1.070	+0.5
22	22709	34042	78.6	24146	36193	79.1	22	0.973	0.972	-0.9	1.063	1.063	+0.5
23	25839	38872	82.1	27342	41049	82.6	23	0.975	0.971	-1.0	1.058	1.056	+0.5
24	29275	44175	85.7	30870	46473	86.2	24	0.975	0.970	-1.0	1.054	1.052	+0.5
25	32990	49882	89.2	34732	52425	89.8	25	0.974	0.966	-1.0	1.053	1.051	+0.6
26	36953	55994	92.6	38909	58843	93.3	26	0.971	0.962	-1.1	1.053	1.051	+0.7
27	41129	62428	96.0	43360	65595	96.7	27	0.968	0.957	-1.2	1.054	1.051	+0.7
28	45500	69086	99.4	48044	72715	100.0	28	0.965	0.949	-1.3	1.056	1.053	+0.6
29	50071	76087	102.6	52933	80134	103.5	29	0.961	0.944	-1.5	1.057	1.053	+0.9
30	54891	83327	106.0	58046	87922	106.7	30	0.959	0.937	-1.6	1.057	1.055	+0.7
31	60064	91197	109.2	63465	95980	110.1	31	0.957	0.934	-1.8	1.057	1.052	+0.9
32	65758	99642	112.5	69371	104913	113.4	32	0.957	0.929	-2.1	1.055	1.053	+0.9
33	72210	109231	115.8	76051	114612	116.8	33	0.957	0.927	-2.4	1.053	1.049	+1.0
34	79721	120445	119.3	83895	126217	120.4	34	0.957	0.926	-2.4	1.052	1.048	+1.1
35	88641	133711	122.9	93384	140040	124.2	35	0.958	0.925	-2.6	1.054	1.047	+1.3
36	99347	149443	126.7	105037	156980	128.1	36	0.958	0.924	-2.9	1.057	1.050	+1.4
37	112203	168709	130.8	119341	177871	132.4	37	0.958	0.925	-2.9	1.064	1.054	+1.6
38	127514	191446	135.3	136662	202921	136.9	38	0.958	0.926	-2.8	1.072	1.060	+1.6
39	145472	218175	140.1	157146	232666	141.8	39	0.958	0.928	-2.7	1.080	1.066	+1.7
40	166103	248660	145.2	180633	266355	147.0	40	0.959	0.931	-2.7	1.087	1.071	+1.8
41	189218	282737	150.6	206612	303671	152.2	41	0.962	0.936	-2.4	1.092	1.074	+1.6
42	214389	318908	156.1	234284	343760	157.6	42	0.965	0.939	-2.4	1.093	1.078	+1.5
43	240962	356822	161.4	262781	384639	162.6	43	0.969	0.941	-2.4	1.091	1.078	+1.2
44	268135	395394	166.1				44	0.971	0.942	-2.5			

Table B17. Model 5653-3 measurement uncertainties

24 knot Ship Speed							
Measurement	Units	Nominal Mean	Bias Error ±	Precision Error ±	Uncertainty* (units) ±	(percent) ±	Four Shafts (percent) ±
Speed	ft/sec	6.98	0.002	0.004	0.004	0.06	-
Resistance	lbf	15.26	0.059	0.162	0.172	**1.13**	-
INbd Prop Shaft Rate	RPM	505.15	0.005	1.71	1.710	0.34	-
OUTbd Prop Shaft Rate	RPM	506.59	0.005	1.24	1.240	0.24	0.29
INbd Shaft Thrust - combined	lbf	6.61	0.056	0.172	0.181	2.74	-
OUTbd Shaft Thrust - combined	lbf	4.30	0.056	0.213	0.220	5.12	3.93
INbd Shaft Torque - combined	lbf-in	13.21	0.096	0.182	0.206	1.56	-
OUTbd Shaft Torque - combined	lbf-in	10.97	0.096	0.280	0.296	2.70	2.13
INbd Shaft Power - combined	hP	0.106	0.0008	0.0015	0.0017	1.59	-
OUTbd Shaft Power - combined	hP	0.088	0.0008	0.0023	0.0024	2.71	**2.15**

36 knot Ship Speed							
Measurement	Units	Nominal Mean	Bias Error ±	Precision Error ±	Uncertainty* (units) ±	(percent) ±	Four Shafts (percent) ±
Speed	ft/sec	10.46	0.003	0.002	0.004	0.04	-
Resistance	lbf	33.71	0.065	0.172	0.184	**0.55**	-
INbd Prop Shaft Rate	RPM	752.71	0.006	1.923	1.923	0.26	-
OUTbd Prop Shaft Rate	RPM	751.79	0.006	1.528	1.528	0.20	0.23
INbd Shaft Thrust - combined	lbf	15.27	0.059	0.258	0.265	1.73	-
OUTbd Shaft Thrust - combined	lbf	12.16	0.059	0.261	0.268	2.20	1.97
INbd Shaft Torque - combined	lbf-in	30.26	0.101	0.564	0.573	1.89	-
OUTbd Shaft Torque - combined	lbf-in	26.79	0.101	0.454	0.465	1.74	1.81
INbd Shaft Power - combined	hP	0.361	0.0012	0.0068	0.0069	1.91	-
OUTbd Shaft Power - combined	hP	0.320	0.0012	0.0055	0.0056	1.75	**1.83**

Table B18. JHSS BSS GB FA, dynamic sinkage and trim

	BSS GB DES			BSS GB Flap DES			BSS GB Flap HVY		
VS (knots)	Sinkage FP (ft)	Sinkage AP (ft)	Pitch Angle (degrees)	Sinkage FP (ft)	Sinkage AP (ft)	Pitch Angle (degrees)	Sinkage FP (ft)	Sinkage AP (ft)	Pitch Angle (degrees)
15	0.60	0.10	-0.03	0.78	0.02	-0.05	0.69	0.20	-0.03
16	0.67	0.11	-0.04	0.86	-0.01	-0.05	0.72	0.23	-0.03
17	0.73	0.11	-0.04	0.92	-0.05	-0.06	0.78	0.24	-0.03
18	0.80	0.10	-0.04	1.00	-0.08	-0.07	0.87	0.23	-0.04
19	0.88	0.09	-0.05	1.11	-0.11	-0.07	1.01	0.22	-0.05
20	0.99	0.08	-0.05	1.24	-0.15	-0.08	1.17	0.19	-0.06
21	1.10	0.07	-0.06	1.40	-0.19	-0.10	1.35	0.16	-0.08
22	1.23	0.06	-0.07	1.57	-0.22	-0.11	1.55	0.13	-0.09
23	1.37	0.05	-0.08	1.75	-0.26	-0.12	1.73	0.09	-0.10
24	1.50	0.05	-0.09	1.94	-0.30	-0.13	1.92	0.05	-0.12
25	1.64	0.05	-0.10	2.12	-0.34	-0.15	2.09	0.00	-0.13
26	1.79	0.04	-0.11	2.30	-0.38	-0.16	2.26	-0.06	-0.14
27	1.94	0.03	-0.12	2.49	-0.44	-0.18	2.42	-0.14	-0.15
28	2.10	0.02	-0.13	2.68	-0.51	-0.19	2.60	-0.22	-0.17
29	2.28	0.00	-0.14	2.90	-0.60	-0.21	2.79	-0.32	-0.19
30	2.48	-0.03	-0.15	3.13	-0.69	-0.23	3.00	-0.42	-0.21
31	2.70	-0.06	-0.17	3.40	-0.79	-0.25	3.24	-0.53	-0.23
32	2.94	-0.08	-0.18	3.69	-0.89	-0.28	3.52	-0.64	-0.25
33	3.19	-0.10	-0.20	4.00	-0.98	-0.30	3.82	-0.73	-0.28
34	3.43	-0.08	-0.22	4.32	-1.05	-0.32	4.13	-0.80	-0.30
35	3.66	-0.03	-0.23	4.64	-1.08	-0.35	4.44	-0.82	-0.32
36	3.86	0.09	-0.23	4.93	-1.05	-0.36	4.73	-0.79	-0.34
37	3.99	0.28	-0.23	5.17	-0.95	-0.37	4.97	-0.68	-0.35
38	4.05	0.56	-0.21	5.34	-0.76	-0.37	5.14	-0.48	-0.35
39	4.00	0.94	-0.19	5.40	-0.47	-0.36	5.20	-0.17	-0.33
40	3.84	1.44	-0.15	5.34	-0.07	-0.33	5.14	0.23	-0.30
41	3.56	2.04	-0.10	5.15	0.43	-0.29	4.95	0.74	-0.26
42	3.16	2.74	-0.03	4.86	1.02	-0.23	4.66	1.33	-0.20
43	2.69	3.48	0.04	4.49	1.66	-0.17	4.30	1.98	-0.14
44	2.22	4.21	0.11	4.14	2.27	-0.11	3.97	2.61	-0.08
45	1.84	4.82	0.18	3.94	2.76	-0.07	3.82	3.15	-0.04

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